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ORIGINAL

A Design Science Research Based Business Process Reengineering Methodology to Improve Off Campus Learning Performance in Indonesian Public Universities

Una metodología de reingeniería de procesos de negocio basada en Design Science Research para mejorar el desempeño del aprendizaje fuera del campus en las universidades públicas de Indonesia

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ABSTRACT

Introduction: this study developed and validated a Business Process Reengineering (BPR) methodology to improve Key Performance Indicator 2 (IKU 2, students' off-campus learning experiences) in Indonesian public universities. It focused on Merdeka Belajar Kampus Merdeka (MBKM) processes within a performance-based higher education governance context.
Method: the study adopted a mixed-methods design within a Design Science Research (DSR) framework. It integrated the Analytic Hierarchy Process (AHP), DEMATEL, and DEMATEL-based Analytic Network Process (DANP) to prioritise and map causal relationships among BPR critical success factors. Data were collected through AHP and DEMATEL questionnaires completed by experts, supported by key informant interviews and document analysis.
Results: the results showed that top management support, effective project management, and technological competence acted as dominant system drivers, while resource allocation, comprehensive planning, and availability of technological infrastructure emerged as the most influential sub-factors. These elements were organised into a three-layer architecture and a BPR-DSR blueprint that guided process redesign, governance adjustments, and dashboard-based monitoring of IKU 2. Pilot application indicated that MBKM data validation time decreased by approximately 25-30 percent compared with the baseline semester, data entry errors were reduced by around 40 percent, and cross-unit coordination improved noticeably.
Conclusions: the study extended BPR scholarship to performance-based higher education governance, demonstrated the usefulness of hybrid multi-criteria decision-making within a DSR cycle, and offered PTN-BH institutions a practical roadmap for evidence-based process transformation aligned with national performance targets.

Keywords: Business Process Reengineering; Design Science Research; DEMATEL Based ANP; Higher Education Performance; Off Campus Learning (IKU 2); Indonesian Public Universities.

RESUMEN

Introducción: este estudio desarrolló y validó una metodología de Business Process Reengineering (BPR) para mejorar el Indicador Kunci Kinerja 2 (IKU 2, experiencias de aprendizaje fuera del campus de los estudiantes) en universidades públicas indonesias. Se centró en los procesos de Merdeka Belajar Kampus Merdeka (MBKM) dentro de un contexto de gobernanza de la educación superior basada en el desempeño.
Método: el estudio adoptó un diseño de métodos mixtos dentro de un marco de Design Science Research

(DSR). Integró el Analytic Hierarchy Process (AHP), DEMATEL y el DEMATEL-based Analytic Network Process (DANP) para priorizar y mapear las relaciones causales entre los factores críticos de éxito de BPR. Los datos se recopilaron mediante cuestionarios AHP y DEMATEL completados por expertos, complementados con entrevistas a informantes clave y análisis de documentos.
Resultados: los resultados mostraron que el apoyo de la alta dirección, la gestión eficaz de proyectos y la competencia tecnológica actuaron como impulsores dominantes del sistema, mientras que la asignación de recursos, la planificación integral y la disponibilidad de infraestructura tecnológica surgieron como los subfactores más influyentes. Estos elementos se organizaron en una arquitectura de tres niveles y en un plan maestro BPR–DSR que orientó el rediseño de procesos, los ajustes de gobernanza y el monitoreo mediante paneles (dashboard) del IKU 2. La aplicación piloto indicó que el tiempo de validación de los datos MBKM disminuyó aproximadamente un 25–30 % en comparación con el semestre de referencia, los errores de ingreso de datos se redujeron al
Conclusiones: el estudio amplió la literatura de BPR hacia la gobernanza de la educación superior basada en el desempeño, demostró la utilidad de la toma de decisiones multicriterio híbrida dentro de un ciclo de DSR y ofreció a las instituciones PTN-BH una hoja de ruta práctica para la transformación de procesos basada en evidencia y alineada con los objetivos nacionales de desempeño.

Palabras clave: Reingeniería de Procesos de Negocio; Design Science Research; Proceso de Red Analítica (ANP) Basado en DEMATEL; Desempeño de la Educación Superior; Aprendizaje Fuera del Campus (IKU 2); Universidades Públicas de Indonesia.

INTRODUCTION

In the current wave of digital transformation, universities are increasingly expected to demonstrate levels of agility, accountability, and service quality comparable to private sector organisations. Business Process Reengineering (BPR) has been promoted as a strategic approach to achieve major improvements in cost, quality, service, and speed through fundamental rethinking and radical redesign of core processes.[1,2] Empirical studies, however, indicate that a large proportion of BPR initiatives, often estimated at 50 to 70 percent, fail to deliver their intended benefits, mainly due to weak change management, limited process understanding, and neglect of culture and human factors.[3,4,5] These findings suggest that BPR success depends not only on technical process design but also on a configuration of critical success factors (CSFs) that combine managerial, technological, and socio-cultural dimensions. In this study, these CSFs are conceptualised as top management support, effective project management, technological competence, change management, employee involvement, and process maturity, which together shape the effectiveness of BPR implementation and, ultimately, organisational performance.

In Indonesia, higher education is undergoing a parallel transformation driven by the Merdeka Belajar Kampus Merdeka (MBKM) policy, which promotes curriculum flexibility, external collaboration, and stronger linkages between universities and the labour market. The Ministry of Education, Culture, Research, and Technology operationalises this agenda through eight Key Performance Indicators (Indikator Kinerja Utama, IKU) for higher education institutions, particularly for public universities with legal-entity status (Perguruan Tinggi Negeri Badan Hukum, PTN-BH). IKU 2, defined as students gaining learning experiences outside the campus, is a pivotal indicator because it reflects the extent of MBKM implementation across study programmes, the intensity of partnerships with industry and communities, and the ability of universities to provide authentic experiential learning opportunities.

Despite strong regulatory support, achievement of IKU 2 remains uneven. National dashboards and institutional performance reports show that only a limited number of PTN-BH have reached high levels of student participation in off-campus learning, while many others continue to fall short of their annual targets. At Universitas Sumatera Utara (USU), for example, internal performance documents indicate that the realisation of IKU 2 in 2023 remained below the planned target, even when several other indicators had been met or exceeded. This gap suggests that the challenge is not only conceptual or pedagogical but is also rooted in fragmented, bureaucratic, and weakly integrated business processes related to MBKM, including multi-layered approval flows, siloed information systems, and limited coordination among faculties, academic bureaus, and external partners.

Existing research has shown that BPR can be implemented in universities to streamline academic and administrative workflows, such as distance learning logistics, student services, and travel management. These studies frequently report reductions in processing time and error rates, as well as improvements in transparency and user satisfaction.[6,7,8] However, most of this work adopts a case-oriented perspective that focuses on redesigning a single process or unit. It rarely offers a systematic methodology for identifying, prioritising, and modelling the CSFs that determine whether BPR in higher education can improve institution-wide performance indicators such as IKU. In addition, classical BPR frameworks, developed mainly in corporate contexts before the current digital era, tend to under-specify soft issues such as organisational culture, academic autonomy, and stakeholder engagement, which are central to decision-making in universities.(8,9,10) As a result, there is limited guidance on how to connect BPR initiatives in higher education to measurable outcomes like student mobility and participation in off-campus learning.

At the methodological level, the literature offers tools that remain underused in BPR research in higher education. Multi-criteria decision-making techniques such as the Analytic Hierarchy Process (AHP) provide structured procedures for eliciting expert judgements and deriving priority weights among competing factors.(11,12) Methods from the Decision-Making Trial and Evaluation Laboratory (DEMATEL) family allow researchers to model complex cause-effect relationships among CSFs and to distinguish between driving and dependent variables, especially when combined with network-based models such as DEMATEL-based Analytic Network Process (DANP).(13,14) Design Science Research (DSR) complements these techniques by offering a rigorous paradigm for designing, implementing, and iteratively refining artefacts such as methods, models, and frameworks that address identified organisational problems.(15,16) Yet only a small number of studies integrate AHP, DEMATEL-type analysis, and DSR into a coherent BPR methodology that is explicitly tailored to MBKM-related processes and to the achievement of IKU performance targets in PTN-BH.

Against this background, the present study addresses three main research gaps. First, although there is an emerging body of work on BPR in higher education, most studies remain focused on isolated process improvements and do not develop a comprehensive methodological model that links CSFs to university-wide performance indicators such as IKU 2. Second, prior research rarely integrates hybrid multi-criteria decision-making techniques, in particular the combination of AHP, DEMATEL, and DANP, with a design-oriented framework such as DSR to support the systematic design and validation of BPR methodologies in universities. Third, the link between BPR initiatives and measurable performance outcomes for off-campus learning, especially in the context of Indonesian PTN-BH operating under MBKM governance, remains empirically underexplored.

This study seeks to address these gaps by examining BPR for the improvement of IKU 2 performance in an Indonesian PTN-BH, with Universitas Sumatera Utara serving as the empirical case. The research has three objectives. The first objective is to identify the CSFs that shape the effectiveness of BPR implementation in universities, particularly for MBKM business processes that underpin IKU 2. The second objective is to analyse the causal structure among these factors and to assess their influence on organisational performance using an integrated AHP and DEMATEL-based approach, including DANP for network modelling. The third objective is to synthesise these insights into a design-oriented BPR methodological model for PTN-BH that aligns process redesign efforts with strategic performance indicators and with the specific governance characteristics of autonomous public universities.

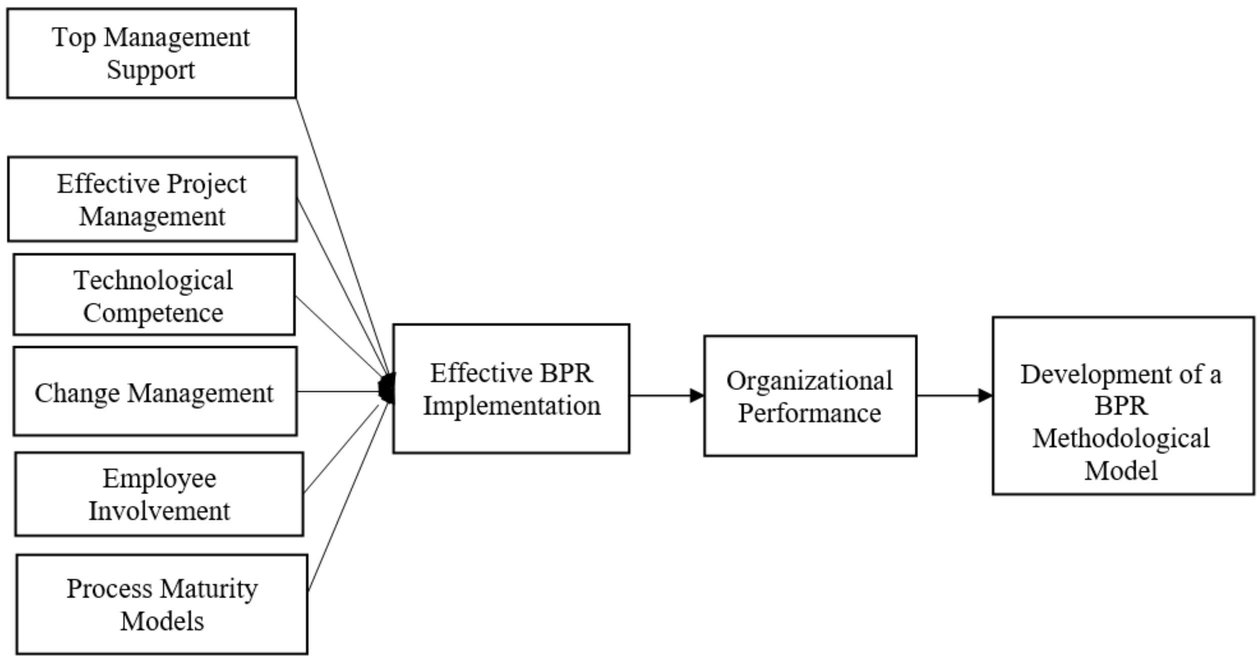

Figure 1. Conceptual model linking critical success factors, effective BPR implementation, organisational performance (IKU 2), and the development of a context-specific BPR methodological model for PTN-BH

Figure 1 presents the conceptual model that links CSFs, effective BPR implementation, organisational performance on IKU 2, and the development of a context-specific BPR methodological model for PTN-BH. In line with this model, the article offers three interrelated contributions. At the theoretical level, it extends BPR scholarship by proposing a context-specific model that links CSFs and their causal relationships directly to higher education performance metrics, with a particular focus on IKU 2 and MBKM implementation in PTN-BH. At the methodological level, it shows how hybrid multi-criteria decision-making techniques can be combined with a DSR cycle to produce a BPR framework that is empirically grounded, transparent, and suitable for complex academic organisations. At the practical level, it provides PTN-BH, and especially Universitas Sumatera Utara, with a structured roadmap for redesigning MBKM-related processes, simplifying administrative procedures, strengthening digital integration across units, and increasing student participation in off-campus learning programmes.

METHOD

Type of study, period, and location

This study adopted a design science research (DSR) approach supported by a mixed-methods design that combined expert-based multi-criteria analysis with qualitative inquiry. The overarching aim was to develop and validate a Business Process Reengineering (BPR) methodological model tailored to improve the performance of Key Performance Indicator 2 (IKU 2), namely students' off-campus learning experiences, at Universitas Sumatera Utara (USU), an autonomous public university (PTN-BH) located in Medan, North Sumatra. The research process unfolded over an academic year spanning two consecutive semesters and followed three sequential phases: diagnostic and conceptualisation, quantitative modelling, and design and evaluation of the BPR methodological model.(17,18)

Population, sample, and sampling

The population of interest comprised stakeholders involved in the design, implementation, and monitoring of Merdeka Belajar Kampus Merdeka (MBKM) processes contributing to IKU 2 at USU. For the quantitative component (AHP and DEMATEL), the study used purposive sampling to recruit a panel of 15 experts. Inclusion criteria were: (1) holding a formal position at the university or faculty level; (2) having at least three years of experience in academic or administrative management; (3) being directly involved in MBKM or IKU 2 implementation and monitoring; and (4) exercising decision-making authority or advisory roles related to process redesign and performance management. This panel included senior managers, MBKM coordinators, heads of academic and administrative units, and IT or information systems managers. Previous methodological literature indicates that expert panels of 10–20 participants are generally sufficient for obtaining stable pairwise comparisons and reliable causal judgements in AHP and DEMATEL applications, so a panel of 15 experts was deemed adequate for this study.

For the qualitative component, five key informants were selected purposively to capture strategic, operational, and technical perspectives on IKU 2-related processes. They included the head of the MBKM unit, an academic leader responsible for curriculum and student affairs, an IT manager overseeing academic information systems, and two faculty-level coordinators involved in day-to-day MBKM administration. Individuals who did not meet the inclusion criteria or were unable to complete the data collection procedures were excluded from the final sample.

Variables analysed

The main variables analysed were six BPR critical success factors and their associated sub-factors in the context of MBKM processes and IKU 2 performance. These included strategic and organisational factors (such as top management support and effective project management), technological and infrastructural factors (such as technological competence and availability of technological infrastructure), and resource and planning-related factors (such as resource allocation and comprehensive planning). The study also considered the performance of IKU 2 as an outcome at the process level, understood in terms of the timeliness, accuracy, and quality of MBKM data and cross-unit coordination. Particular attention was given to explaining and operationalising factors that are less commonly used in higher education BPR studies, such as MBKM-specific governance arrangements and dashboard-based monitoring of performance indicators.

Instruments, techniques, and procedures

The quantitative instruments consisted of an AHP questionnaire and a DEMATEL questionnaire constructed from the six critical success factors and their sub-factors. Experts were asked to perform pairwise comparisons of factors and sub-factors using the standard AHP 1–9 scale and to assess the degree of direct influence among factors for DEMATEL. The qualitative instruments comprised a semi-structured interview guide and a document review protocol. The interview guide covered themes such as MBKM implementation challenges, coordination

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patterns, data flows, and prior experiences with process change, while the document protocol focused on IKU reports, strategic plans, MBKM standard operating procedures, and workflow charts.

The overall procedure followed the logic of DSR. In the diagnostic and conceptual phase, the authors reviewed literature on BPR, critical success factors, and organisational performance in higher education and examined institutional documents to identify candidate factors and map the as-is MBKM workflows. In the quantitative modelling phase, expert judgements were elicited through the AHP and DEMATEL instruments. In the design and evaluation phase, the AHP and DEMATEL results were embedded in a DSR cycle that guided the design, demonstration, and iterative refinement of the BPR methodological model and its three-layer architecture for IKU 2 at USU.[19,20,21,22]

Instrument validation, reliability, and consistency

The AHP and DEMATEL instruments were tested for validity and reliability before their full application. Item validity was assessed using item–total correlations, with all correlation coefficients exceeding the critical r-table value and all significance values below 0,05, indicating that each item adequately represented its intended construct (table 2). Reliability was evaluated using Cronbach’s alpha, yielding coefficients of 0,87 for the AHP questionnaire and 0,91 for the DEMATEL questionnaire. Both values exceeded the commonly accepted threshold of 0,70, reflecting good to very high internal consistency across items (table 3). Additionally, the consistency of expert judgements in the AHP pairwise comparisons met the recommended standard, with all consistency ratio (CR) values below 0,10. These results confirmed that the instruments were psychometrically sound and suitable for analysing priority weights and causal relationships among the critical success factors.

Data collection process

Quantitative data were collected by distributing the validated AHP and DEMATEL questionnaires to the 15 experts via online forms and email. Experts were provided with definitions and examples for each factor and sub-factor to ensure a shared understanding of the constructs. Follow-up reminders were sent to maximise response completeness.

Qualitative data were collected through semi-structured interviews with the five key informants. Interviews were conducted either face-to-face or online, audio-recorded with consent, and subsequently transcribed verbatim. The interviews explored implementation challenges, cross-unit coordination, data validation routines, and experiences with previous process changes. During data collection, no new themes emerged after the fifth interview, indicating thematic saturation for the core issues examined. In parallel, institutional documents (IKU reports, strategic plans, MBKM SOPs, and workflow charts) were reviewed to triangulate interview findings and to map existing MBKM processes in detail.

Data analysis process

The data analysis followed an integrated AHP–DEMATEL–DANP procedure, complemented by qualitative thematic analysis.

For the quantitative strand, three stages were implemented. First, the Analytic Hierarchy Process (AHP) was used to derive priority weights for the critical success factors and their sub-factors from expert pairwise comparisons, producing a consistent hierarchy of factor importance. Second, the Decision Making Trial and Evaluation Laboratory (DEMATEL) method was applied to capture the pattern of causal relationships among the factors. Expert judgements were synthesised into a direct influence matrix, normalised to obtain the total relation matrix, and used to compute the D and R indices. The values of D + R and D − R were then used to assess the overall prominence of each factor and to classify them as net drivers or net receivers in the BPR system. Third, a DEMATEL-based Analytic Network Process (DANP) was employed to integrate the priority weights and causal information. An initial ANP supermatrix was constructed from the AHP-derived weights, adjusted using the DEMATEL influence degrees to form a weighted supermatrix, and iteratively multiplied until a limit supermatrix was obtained. The limit supermatrix provided the final, stable ranking of sub-factors and underpinned the design of the BPR methodological model and its three-layer architecture.

For the qualitative strand, interview transcripts were coded and analysed thematically to identify recurrent patterns related to governance arrangements, coordination mechanisms, data flows, and perceived bottlenecks in MBKM processes. These themes were used to contextualise and refine the interpretation of the quantitative results, to assess the fit between the emerging BPR model and the institutional culture, and to generate design requirements and practical recommendations. The integration of quantitative and qualitative findings supported methodological triangulation and strengthened the validity of the conclusions.

Ethical aspects

The study complied with the ethical guidelines for research involving human participants at Universitas Sumatera Utara. All participants were informed about the purpose of the study, the voluntary nature of their participation, and their right to withdraw at any time without consequence. Informed consent was obtained prior to administering questionnaires and conducting interviews. Expert and informant identities were anonymised in all reports, and data were stored securely with access restricted to the research team.

RESULTS

Data description

The study adopted a mixed-methods design that integrates quantitative expert judgements and qualitative insights to examine Business Process Reengineering (BPR) in relation to the improvement of Key Performance Indicator 2 (IKU 2) in PTNBH institutions in Sumatra. Quantitative data were obtained from Analytic Hierarchy Process (AHP) and Decision-Making Trial and Evaluation Laboratory (DEMATEL) questionnaires completed by 15 experts, while qualitative data were collected through in-depth interviews with five key informants involved in MBKM-related business processes.

Table 1 presents the distribution of AHP and DEMATEL respondents by organisational role and years of experience. Most experts are drawn from management (40 percent) and administrative staff (33 percent), with the remaining 27 percent representing academic staff. In terms of tenure, 60 percent of respondents have more than five years of experience and 40 percent have three to five years of experience. This composition ensures that the judgements reflect informed views from individuals with sufficient authority, operational exposure, and familiarity with business process and performance management.

All AHP and DEMATEL questionnaires were checked for completeness and internal consistency and were deemed suitable for further analysis. The responses exhibit meaningful variation in perceived priorities and interrelationships among BPR critical success factors, indicating that the underlying business process issues are complex and multidimensional. Qualitative data from the five key informants complement these patterns. Informants were purposively selected based on their strategic roles in MBKM administration, academic governance, and BPR implementation, and their narratives provide contextual detail on implementation challenges, managerial support, operational bottlenecks, and expectations for a more effective BPR methodology. Taken together, the quantitative and qualitative evidence provide a robust empirical basis for prioritising variables, mapping causal relationships, and designing a context-sensitive BPR methodological model for PTNBH in Sumatra.

Table 1. Questionnaire Respondent Distribution

Characteristic	Frequency	Percentage
Management	6	40 %
Administrative Staff	5	33 %
Academic	4	27 %
> 5 years of experience	9	60 %
3-5 years of experience	6	40 %

Measurement quality

Instrument quality was assessed in terms of validity and reliability to ensure that the AHP and DEMATEL questionnaires accurately captured expert judgements on Business Process Reengineering (BPR) critical success factors in the PTNBH context.

For validity, Pearson product-moment correlations were calculated between each AHP item and the total score for the six main variables: top Management Support, Effective Project Management, Technological Competence, Change Management, Employee Involvement, and Process Maturity Models.

Table 2. Results of AHP Instrument Validity Test

Variable Ítem	r-value	r-table	Sig.	Remarks
Top Management Support	0,752	0,514	0,002	Valid
Effective Project Management	0,830	0,514	0,000	Valid
Technological Competence	0,788	0,514	0,001	Valid
Change Management	0,745	0,514	0,003	Valid
Employee Involvement	0,735	0,514	0,004	Valid
Employee Involvement	0,735	0,514	0,004	Valid
Process Maturity Models	0,710	0,514	0,006	Valid

With 15 respondents, the critical r value at the 5 percent significance level is 0,514. All items show r values above 0,514 with p values below 0,05, indicating statistically significant correlations and satisfactory item validity. These results confirm that the AHP instrument adequately represents the intended constructs and is suitable for measuring expert priorities regarding BPR factors in PTNBH institutions.

Reliability was evaluated using Cronbach's alpha for both the AHP and DEMATEL questionnaires. The AHP questionnaire yields an alpha of 0,87 and the DEMATEL questionnaire an alpha of 0,91. Both coefficients are well above the commonly accepted threshold of 0,70, indicating very good and excellent internal consistency respectively. Taken together, the validity and reliability results provide strong evidence that the instruments are psychometrically sound and that the data are robust for subsequent AHP, DEMATEL, and DANP analyses.

Table 3. Results of Research Instrument Reliability Test

Measurement Instrument	Number of Items	Cronbach's Alpha	Interpretation
AHP Questionnaire	6	0,87	Very good reliability
DEMATEL Questionnaire	6	0,91	Excellent reliability

Step 1 (AHP-based prioritisation of BPR factors)

Step 1 focuses on identifying and ranking the key success factors for BPR in supporting IKU 2. Using AHP, expert pairwise comparisons were synthesised into priority weights for the six main variables (table 4). The results show a clear three tier structure. Top Management Support, Effective Project Management, and Technological Competence form the first tier and act as the most influential factors in the system. Change Management, Employee Involvement, and Process Maturity Models occupy a second tier, indicating that they remain important but are relatively less powerful as initial drivers of change.

Table 5 refines this picture by examining the weights of the sub variables. Resource Allocation under Top Management Support, Comprehensive Planning under Effective Project Management, and Availability of Technological Infrastructure under Technological Competence have the highest global weights. Taken together, these patterns suggest that effective BPR for IKU 2 must be anchored in three core elements: strong and committed leadership that allocates adequate resources, disciplined project planning and control, and sufficient digital infrastructure to support MBKM related processes. Other factors such as change management and employee involvement operate as tactical enablers whose impact depends on the strength of these strategic foundations.

Table 4. Pairwise Comparison Results Using the AHP Method

Variable	Priority Weight	Rank
Top Management Support	0,3406	1
Effective Project Management	0,2598	2
Technological Competence	0,1859	3
Change Management	0,1046	4
Employee Involvement	0,0705	5
Process Maturity Models	0,0387	6

Table 5. Priority Weights of Variables and Sub-Variables

Main Variable	Sub-Variable	Local Weight	Global Weight
Top Management Support	Commitment and Leadership	0,0978	0,0342
Top Management Support	Resource Allocation	0,6276	0,2197
Top Management Support	Involvement in Strategic Decision-Making	0,2745	0,0961
Effective Project Management	Comprehensive Planning	0,7291	0,1823
Effective Project Management	Risk Management	0,1355	0,0339
Effective Project Management	Monitoring and Evaluation	0,1354	0,0339
Technological Competence	Appropriate Technology Implementation	0,0200	0,0030
Technological Competence	Availability of Technological Infrastructure	0,6726	0,1009
Technological Competence	Technological Human Resource Capability	0,3074	0,0461
Change Management	Effective Communication Strategy	0,2589	0,0259
Change Management	Employee Training and Development	0,0044	0,0004
Change Management	Management of Resistance to Change	0,7367	0,0737

Employee Involvement	Employee Involvement in Process Design	0,8026	0,0642
Employee Involvement	Employee Empowerment	0,1072	0,0086
Employee Involvement	Feedback and Recognition	0,0902	0,0072
Process Maturity Models	Process Maturity Level	0,1547	0,0108
Process Maturity Models	Adoption of Best Practices	0,2771	0,0194
Process Maturity Models	Involvement in Evaluation and Continuous Improvement	0,5682	0,0398

Step 2 (DEMATEL-based causal analysis)

Step 2 examines the causal structure among the BPR factors using DEMATEL. Descriptive statistics for the influence scores (table 6) indicate a reasonable spread of values without extreme outliers, which is consistent with the assumptions of DEMATEL and confirms that the experts perceive meaningful interactions among all variables. The direct relation matrix (table 7) shows that Top Management Support, Effective Project Management, and Technological Competence have relatively high outgoing influence, reinforcing their role as system drivers rather than passive components.

After normalisation, the total relation matrix (table 8) captures both direct and indirect effects and allows the computation of D and R indices for each variable. At the sub variable level, the summary of D, R, D plus R, and D minus R (table 9) reveals a clear driver receiver pattern. Resource Allocation, Comprehensive Planning, and Availability of Technological Infrastructure have the highest positive D minus R values and are classified as primary drivers. By contrast, human related and maturity related sub variables, such as Training and Development, Employee Empowerment, and Continuous Evaluation, show negative D minus R values and are classified as receivers. IKU 2 appears as a high prominence receiver and functions as a system outcome.

The quadrant map of DEMATEL results (figure 2) summarises these relationships visually. Sub variables in the driver quadrant form the main leverage points for intervention, while those in the receiver and outcome quadrants represent areas where improvement is realised once upstream drivers have been strengthened. This structure supports a staged intervention logic in which strategic and technological drivers are addressed first, followed by consolidation of human and maturity related elements.

Table 6. Distribution Test Results

Parameter	Value
Minimum	1,2
Maximum	4,9
Mean	3,15
Standard Deviation	1,08

Table 7. Direct-Relation Matrix for the Seven Variables

	Top Management Support	Effective Project Management	Technological Competence	Change Management	Employee Involvement	Process Maturity Models	Organizational Performance (IKU 2)
Top Management Support	0,00	0,75	0,55	0,35	0,20	0,30	0,70
Effective Project Management	0,90	0,00	0,70	0,45	0,25	0,20	0,60
Technological Competence	0,60	0,80	0,00	0,55	0,40	0,30	0,55
Change Management	0,85	0,65	0,70	0,00	0,60	0,35	0,45
Employee Involvement	0,70	0,60	0,85	0,65	0,00	0,45	0,40
Process Maturity Models	0,45	0,35	0,50	0,35	0,30	0,00	0,35
Organizational Performance (IKU 2)	0,10	0,08	0,10	0,06	0,06	0,05	0,00

Table 8. Total Relation Matrix (T) - Seven Variables							
	Top Management Support	Effective Project Management	Technological Competence	Change Management	Employee Involvement	Process Maturity Models	Organizational Performance (IKU 2)
Top Management Support	0,3863	0,5309	0,4858	0,3496	0,2525	0,2548	0,5215
Effective Project Management	0,6367	0,4103	0,5618	0,5618	0,2897	0,2578	0,5450
Technological Competence	0,6060	0,6129	0,4285	0,4463	0,3382	0,2929	0,5524
Change Management	0,7241	0,6498	0,6556	0,3651	0,4180	0,3395	0,5911
Employee Involvement	0,7071	0,6523	0,6992	0,5278	0,2868	0,3687	0,5896
Process Maturity Models	0,4519	0,4091	0,4387	0,3237	0,2563	0,1637	0,3996
Organizational Performance (IKU 2)	0,0983	0,0893	0,0930	0,0662	0,0541	0,0482	0,0663

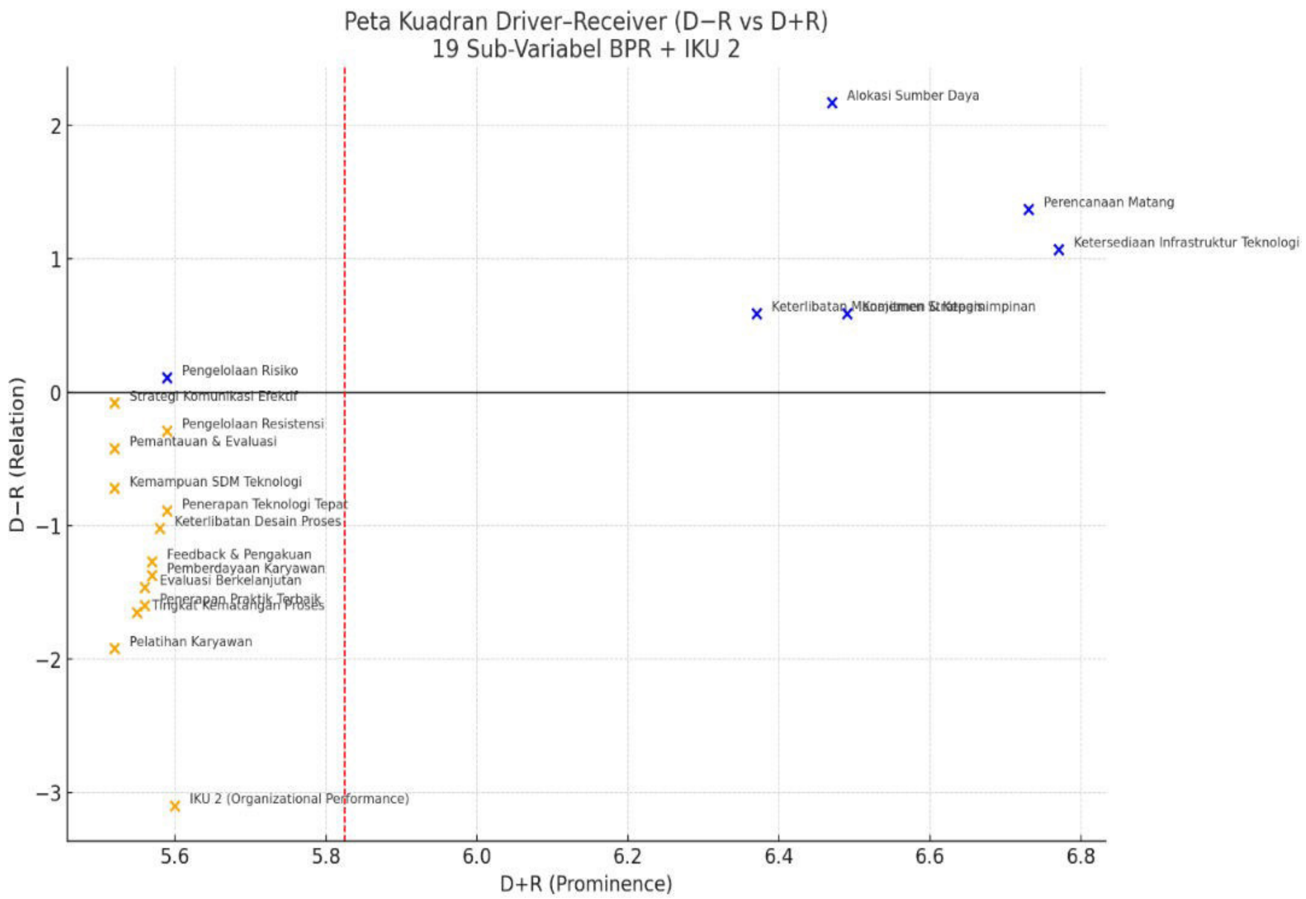

Figure 2. Quadrant Map of DEMATEL Results for All Sub-Variables

Table 9. Summary of D, R, D+R, and D−R Scores (18 Sub-Variables)						
No.	Sub-Variable	D (Out)	R (In)	D+R (Prominence)	D−R (Relation)	Category
1	Resource Allocation	4,32	2,15	6,47	+2,17	Driver
2	Comprehensive Planning	4,05	2,68	6,73	+1,37	Driver
3	Availability of Technological Infrastructure	3,92	2,85	6,77	+1,07	Driver
4	Commitment & Leadership	3,54	2,95	6,49	+0,59	Driver

5	Strategic Managerial Involvement	3,48	2,89	6,37	+0,59	Driver
6	Risk Management	2,85	2,74	5,59	+0,11	Weak driver
7	Effective Communication Strategy	2,72	2,80	5,52	−0,08	Linkage/Receiver
8	Management of Resistance	2,65	2,94	5,59	−0,29	Receiver
9	Monitoring & Evaluation	2,55	2,97	5,52	−0,42	Receiver
10	Technological Human Resource Capability	2,40	3,12	5,52	−0,72	Receiver
11	Appropriate Technology Implementation	2,35	3,24	5,59	−0,89	Receiver
12	Involvement in Process Design	2,28	3,30	5,58	−1,02	Receiver
13	Feedback & Recognition	2,15	3,42	5,57	−1,27	Receiver
14	Employee Empowerment	2,10	3,47	5,57	−1,37	Receiver
15	Involvement in Continuous Evaluation	2,05	3,51	5,56	−1,46	Receiver
16	Adoption of Best Practices	1,98	3,58	5,56	−1,60	Receiver
17	Process Maturity Level	1,95	3,60	5,55	−1,65	Receiver
18	Employee Training & Development	1,80	3,72	5,52	−1,92	Receiver
19	Organizational Performance (IKU 2)	1,25	4,35	5,60	−3,10	Main receiver (Outcome)

Step 3 (Integrated prioritisation with DANP)

Step 3 integrates the AHP based priorities with the DEMATEL based causal structure using DEMATEL based Analytic Network Process (DANP). The normalised ANP supermatrix (Table 10) provides an initial ranking of the 18 sub variables, again highlighting Resource Allocation, Comprehensive Planning, and Availability of Technological Infrastructure as the most influential elements. These weights are then adjusted using the DEMATEL influence degrees to form a weighted supermatrix (Table 11), so that sub variables with stronger outgoing influence receive higher adjusted weights, while receiver variables are stabilised or slightly reduced.

Iterative multiplication of the weighted supermatrix produces the limit supermatrix, which represents the final, stable ranking of sub variables (Table 12). The top positions are consistently occupied by Resource Allocation, Comprehensive Planning, Availability of Technological Infrastructure, Strategic Managerial Involvement, Leadership Commitment, Risk Management, Management of Resistance to Change, Technological Human Resource Capability, Employee Involvement in Process Design, and Continuous Evaluation.

Table 10. Normalised ANP Supermatrix Results

Main Variable	Sub-Variable	Normalised Weight
Top Management Support	Commitment and Leadership	0,0342
	Resource Allocation	0,2197
	Involvement in Strategic Decision-Making	0,0961
Effective Project Management	Comprehensive Planning	0,1823
	Risk Management	0,0339
	Monitoring and Evaluation	0,0339
Technological Competence	Appropriate Technology Application	0,0030
	Availability of Technological Infrastructure	0,1009
	Technological Human Resource Capability	0,0461
Change Management	Effective Communication Strategy	0,0259
	Employee Training and Development	0,0004
	Management of Resistance to Change	0,0737
Employee Involvement	Involvement in Process Design	0,0642
	Employee Empowerment	0,0086
	Feedback and Recognition	0,0072
Process Maturity Models	Process Maturity Level	0,0108
	Adoption of Best Practices	0,0194
	Involvement in Continuous Evaluation and Improvement	0,0398
Total		1,0000

These results confirm that BPR initiatives aimed at improving IKU 2 should begin with resource and planning decisions at the top management level, ensure technological readiness, and then address risk, resistance, capacity building, and continuous evaluation. Employee focused and maturity related variables remain important, but they become most effective once the main drivers have been firmly established.

Table 11. Weighted Supermatrix

Main Variable	Sub-Variable	ANP Normalised Weight	Adjusted Influence (DEMATEL)	Weighted Supermatrix
Top Management Support	Resource Allocation	0,2197	0,497	0,1092
Effective Project Management	Comprehensive Planning	0,1823	0,572	0,1043
Technological Competence	Availability of Technological Infrastructure	0,1009	0,461	0,0928
Top Management Support	Strategic Managerial Involvement	0,0961	0,438	0,0893
Top Management Support	Commitment and Leadership	0,0342	0,410	0,0746
Effective Project Management	Risk Management	0,0339	0,391	0,0735
Change Management	Management of Resistance to Change	0,0737	0,385	0,0679
Technological Competence	Technological Human Resource Capability	0,0461	0,372	0,0625
Employee Involvement	Involvement in Process Design	0,0642	0,354	0,0591
Process Maturity Models	Continuous Evaluation	0,0398	0,336	0,0567

Table 12. Limit Supermatrix

Main Variable	Sub-Variable	Final Weight (Limit)	Rank
Top Management Support	Resource Allocation	0,1383	1
Effective Project Management	Comprehensive Planning	0,1321	2
Technological Competence	Availability of Technological Infrastructure	0,1176	3
Top Management Support	Strategic Managerial Involvement	0,1131	4
Top Management Support	Commitment and Leadership	0,0945	5
Effective Project Management	Risk Management	0,0931	6
Change Management	Management of Resistance to Change	0,0860	7
Technological Competence	Technological Human Resource Capability	0,0791	8
Employee Involvement	Involvement in Process Design	0,0749	9
Process Maturity Models	Continuous Evaluation	0,0718	10

DSR-based BPR methodological model

The final step translates the integrated AHP, DEMATEL, and DANP results into a Business Process Reengineering (BPR) methodological model framed within a Design Science Research (DSR) approach. The model is organised around three interrelated cycles. The relevance cycle connects the artefact to the problem context of low IKU 2 performance in PTN BH by drawing on evidence of the gap between actual and target IKU 2 values and on qualitative findings regarding bureaucratic bottlenecks, fragmented information systems, and weak coordination in MBKM processes. The rigor cycle anchors the model in established literature on BPR, project management, and performance management, as well as in the validated analytical procedures used in this study (AHP, DEMATEL, and DANP). The design cycle then uses the empirically derived priorities and causal structure to design, demonstrate, evaluate, and iteratively refine a BPR methodology that is specifically tailored to improving IKU 2 in an autonomous public university context.

The resulting BPR–DSR blueprint (figure 3) highlights three main design implications. First, redesigned standard operating procedures and end to end process flows must explicitly embody the key drivers identified in the quantitative analysis, particularly resource allocation, comprehensive planning, and technological integration across MBKM processes. Second, linkage variables such as risk management, change communication, and resistance management should be incorporated as built in support mechanisms to stabilise and de risk the redesigned processes. Third, receiver variables, including employee involvement and continuous evaluation, need to be institutionalised through routine practices and digital monitoring so that performance improvements can be sustained and scaled over time.

As part of the design cycle, the proposed BPR–DSR methodology was piloted in the MBKM unit and compared with the previous IKU 2 reporting cycle. Based on internal monitoring of average validation time per reporting batch and the number of detected data entry errors, the average time required to validate MBKM data decreased by about 25 to 30 percent, while the number of data entry errors per batch fell by around 40 percent. Cross unit coordination also improved, as reflected in more timely submissions from faculties and fewer iterations in the correction process. Expert validation and stakeholder feedback confirm that the BPR–DSR model is feasible, contextually relevant, and operationally capable of producing measurable gains in process efficiency, data quality, and transparency in IKU 2 reporting. These results provide the basis for the integrated discussion and final model formulation presented in the next subsection.

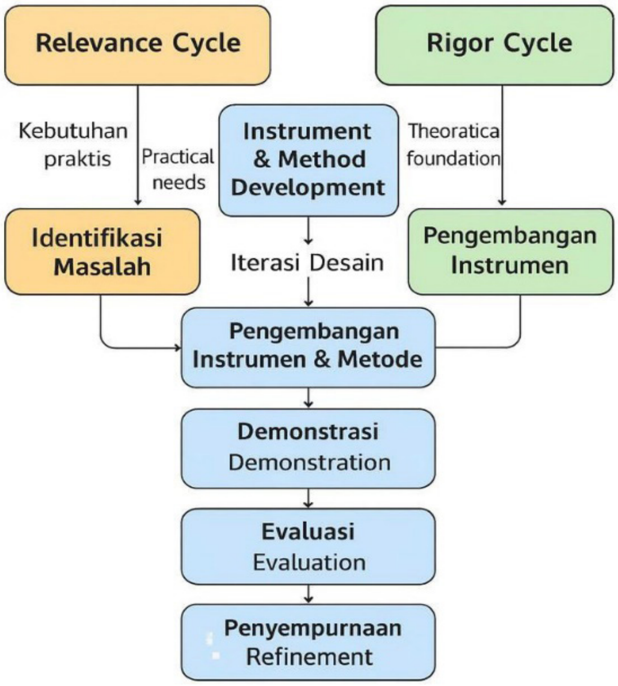

Figure 3. Blueprint of the DSR-Based BPR Methodology

DISCUSSION

Integration of quantitative findings within DSR

This study set out to design and validate a BPR methodological model for improving IKU 2 performance in Indonesian PTN BH by integrating multi criteria decision making techniques (AHP, DEMATEL, DANP) within a Design Science Research (DSR) framework. The AHP results show that Top Management Support, Effective Project Management, and Technological Competence consistently emerge as primary strategic drivers at both factor and sub factor levels, with Resource Allocation, Comprehensive Planning, and Technological Infrastructure identified as the most critical sub variables. DEMATEL clarifies the causal structure among these factors and confirms their role as high influence drivers in the BPR system, while DANP combines priority weights and influence patterns into a stable network based ranking that organises sub variables into a Driving Layer, an Enabling Layer, and an Outcome Layer.[23] Within the DSR paradigm, these quantitative outputs are treated as design requirements that guide the construction of the BPR–DSR blueprint and are iteratively refined through cycles of design, evaluation, and revision, in line with established guidance on design science in information systems and management research.[21,22]

Theoretical implications

The configuration of Top Management Support, Effective Project Management, and Technological Competence as dominant drivers reinforces and extends prior BPR scholarship. Earlier studies emphasise that leadership commitment, clear project governance, and IT capability are central to successful process redesign in both corporate and university contexts.[8,24,25] The present findings confirm this pattern and further demonstrate that these drivers operate through specific mechanisms, namely resource allocation, comprehensive planning, and technological infrastructure, which need to be prioritised before human resource and culture related interventions can generate durable effects. The layered architecture derived from the DANP results, with a

Driving Layer, an Enabling Layer, and an Outcome Layer, supports a systems view of BPR in which employee involvement, process maturity, and other socio cultural variables become effective once strategic and technological foundations have been established.[26,27] Conceptually, the model adds to the literature by linking BPR critical success factors directly to higher education performance metrics such as IKU 2, which has been largely absent in earlier work that focuses on local process improvements without explicit connection to institutional key performance indicators.[1,28]

Practical implications

From a practical perspective, the BPR-DSR blueprint provides PTN BH with a structured roadmap for redesigning MBKM related business processes in a way that is both context sensitive and performance oriented. The layered design suggests a staged implementation logic. Universities should first secure leadership commitment and resource allocation, enforce disciplined project and risk management, and ensure adequate technological readiness. They can then progressively strengthen change management, technological human resource capability, and employee involvement in process design, and finally consolidate process maturity and continuous evaluation. In operational terms, redesigned SOPs and end to end MBKM workflows should explicitly encode the identified drivers, while embedding mechanisms for risk management, change communication, and resistance management within routine governance arrangements.[4,9,29] The recommendation to develop a digital IKU dashboard translates the model into a decision support tool that enables real time monitoring of off campus learning participation, early detection of bottlenecks, and evidence based managerial responses. Pilot application at Universitas Sumatera Utara indicates that this integrated approach can reduce validation time, lower data errors, and improve cross unit coordination, illustrating how a design oriented BPR methodology can produce tangible gains in process efficiency and performance in higher education.[6,30,31]

Limitations and future research

Several limitations should be acknowledged. First, the empirical work is based on a single PTN BH case in Sumatra with a relatively small expert panel, which restricts the generalisability of the specific weight values and causal strengths, even though the observed patterns are theoretically plausible and methodologically robust.[21,22] Second, the evaluation focuses on pilot implementation and short term improvements within one MBKM unit, so the long term sustainability of the BPR-DSR model and its wider organisational impact remain to be examined. Third, the study concentrates on IKU 2 and does not explicitly model interactions with other IKU indicators that may be influenced by the same processes.

These limitations open several avenues for future research. Comparative multi institution studies could test whether the layered structure and priority configuration identified here hold across different PTN BH and non PTN BH universities and in other regions or national contexts. Longitudinal evaluations could track the effects of the BPR-DSR model over multiple planning cycles to assess stability, learning effects, and potential unintended consequences. Future work could also extend the approach to other IKU dimensions or to additional educational and administrative domains, thereby exploring how design oriented and MCDM informed BPR models can support broader performance based governance in higher education.

CONCLUSIONS

This study develops and validates an integrated Business Process Reengineering (BPR) and Design Science Research (DSR) methodological model to improve IKU 2 performance in Indonesian public universities with legal entity status (PTN BH), using a mixed methods design that combines AHP, DEMATEL, and DANP to prioritise critical success factors and map their causal relationships in MBKM related processes at Universitas Sumatera Utara. The findings show that Top Management Support, Effective Project Management, and Technological Competence, operationalised through resource allocation, comprehensive planning, and availability of technological infrastructure, are the main drivers of successful BPR for IKU 2, while Change Management, Employee Involvement, and Process Maturity function as enabling and receiving elements that become effective once these strategic foundations are in place. The resulting BPR-DSR blueprint and IKU 2 dashboard concept provide a structured roadmap for redesigning SOPs and process flows, strengthening governance, and integrating digital systems across units, and pilot application indicates improvements in validation time, data quality, and cross unit coordination. The study thus extends BPR scholarship to KPI based higher education governance, demonstrates the value of hybrid multi criteria decision making within a DSR cycle, and offers PTN BH a context sensitive, evidence based tool for process transformation, while recognising that the single case design and limited expert panel call for further testing, refinement, and replication in other institutions and IKU domains.

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