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Competency-Based Frameworks in Atomotive Body Development: A Systematic Literature Review

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Abstract

Purpose – This study examines the correlation between individual competencies and project performance in the context of international automotive body development. Increasing cross-border outsourcing among suppliers has intensified the demand for project planning methodologies that consider variations in individual skills and behavioral characteristics. The precise assessment of development timescales is affected by both technical proficiency and interpersonal abilities, including communication, collaboration, and decision-making.

Methodology – A systematic literature review was conducted to analyze peer-reviewed research published between 1999 and 2025. The review process included structured database searches, thematic screening, and quality assessment. Studies were selected using predefined inclusion and exclusion criteria and organized into thematic categories.

Findings – A total of 33 relevant studies were identified and classified into four thematic clusters: project management, competency development and learning, recruitment and internships, and automotive-specific skills. The review reveals a growing interest in competency-based approaches but also identifies a consistent gap in linking individual competencies to measurable performance in automotive body development projects. The findings emphasize the importance of integrating behavioral attributes such as teamwork, leadership, and adaptability with technical knowledge in order to improve project outcomes.

Originality – Although the broader project management literature increasingly addresses the role of competencies, few studies focus specifically on the automotive body development context. This paper proposes a holistic, competency-based planning framework that incorporates both behavioral and technical dimensions of performance. Such an approach may enhance time estimation, resource allocation, and stakeholder coordination in complex, internationally distributed development settings.

Keywords: project planning, job performance, individual competencies, automotive industry, cross-border projects

Paper type: Review Article

1. Introduction

In the aftermath of the worldwide economic crisis of 2007, various scholarly investigations have been conducted on the outsourcing procedures of European automotive enterprises. Hoffmann, Wallau, and Kayser (2009) and Kremic, Tukel, and Rom (2006) have identified numerous potential issues associated with outsourcing. They include the loss of knowledge, unrealized cost savings that may lead to increased expenses, employee morale concerns, supplier dependence, missed future business opportunities, and customer dissatisfaction. Moreover, recent changes in international industrial policy, particularly those influenced by China's strategic initiatives, have directly impacted investment flows and technological integration in the European automotive sector, especially in Central Eastern Europe (Lukács & Völgyi, 2021). These issues are being spread indirectly through secondary or tertiary channels, not with the resumption of operations. The statement suggests that local (or European) companies supply goods and services to producers while labor is performed abroad. Therefore, it can be observed that primary suppliers possess a singular crossover function among firms. Due to supplier cost pressures, projects backed by Western salaries cannot be profitable. Thus, more supplier cross-border projects have evolved. In particular outsourcing work to Eastern Europe or abroad has been undertaken as long as customer trust and proximity maintained. This shift aligns with broader global trade trends, where regulatory and economic agreements increasingly shape regional outsourcing strategies and supplier roles (Lukács & Völgyi, 2018). Within the engineering discipline, technical expertise has traditionally been regarded as a cornerstone of professional knowledge. This is particularly evident in the context of vehicle

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body development. However, this narrow emphasis on domain-specific knowledge risks marginalizing equally critical factors such as behavioral attributes, interpersonal capabilities, and soft skills. While technical proficiency remains essential, it alone is no longer sufficient. Competencies, such as effective communication, teamwork, adaptability, and creative problem-solving are increasingly recognized as vital for sustained professional success (Hódosi et al., 2023). Personal traits including resilience, flexibility, and innovation also contribute significantly to project performance in complex engineering environments. As a result, body development projects face considerable uncertainty in the planning. Project managers must organize complex interfaces while also motivating and integrating contributors with significantly varying abilities and work styles.

Preliminary observations from industrial practice suggest that a core source of planning difficulty lies in estimating the time and effort required during development phases (Süle, 2013). These estimates are strongly shaped by each contributor's skills, personal attributes, motivation, and decision effectiveness. This acknowledgment highlights the necessity for a reformed strategy in project planning and management. Such a strategy should enhance professional and technical expertise with insights from related fields and behavior-driven evaluation. Nearly a decade of experience indicates that assessing performance solely through professional background is insufficient; a multidisciplinary, competency-based examination is necessary.

During the research, the authors' aim was to answer the following questions:

RQ1: What are the most significant individual competencies in the field of vehicle body development? RQ2: What are the potential strategies that an evaluation system could utilize to comprehensively assess all aspects of an employee´s performance in a specific project?

This comprehensive literature review addresses a number of interconnected gaps that currently limit evidence-based planning in automotive body development. Existing literature typically focuses on the automotive sector broadly or on generic project management practices. This work emphasizes body development as a unique engineering subdomain, distinguished by intricate interfaces, gateway maturity, and supplier coordination. In this context, competency requirements and failure modes significantly diverge from those observed in more general engineering environments. Conceptual diversity further impedes synthesis. Studies often mix individual, team, and organizational dimensions under the term "competency," and they utilize disparate labels that restrict both comparability and practical application. Moreover, despite its robust predictive validity, the Behavioral Event Interview (BEI) has only been occasionally adapted for engineering-centric environments only. As a result, empirical evidence remains limited regarding its relevance, limitations, and required modifications. Finally, findings are often presented without adequate attention to contextual moderators, such as development phase, organizational setting, or geographic– cultural environment, despite the significance of these elements in cross-border staffing and distributed engineering work.

This systematic evaluation mitigates these constraints by focusing on body development and implementing a consistent individual-level taxonomy that integrates both behavioral and technical competencies. It combines bibliometric mapping with qualitative synthesis to delineate thematic clusters and to characterize the evidentiary environment, indicating that explicit links between individual competencies and project performance are rare, fragmentary, or absent. Alongside this, the review offers a critical appraisal of method usage with a focus on BEI, considering its appropriateness for engineering contexts and specifying workable adaptations (e.g., standardized interviewing protocols, coder calibration, digital transcription and coding). This emphasis is justified as BEI derives evidence from actual, role-critical incidents rather than self-reports. It has consistently demonstrated the ability to differentiate between exceptional and average performance by focusing on the intensity, scope of impact, and complexity of observed behavior (Spencer & Spencer, 1993).

This review aims to establish the theoretical foundation for the authors´ doctoral research. It integrates relevant concepts and outlines an individual-level, hybrid framework encompassing behavioral characteristics and technical expertise. Building on these insights, the research formulates a BEI-based competency model specifically designed for automotive body development and later assesses its efficacy in independent project environments.

2. Literature review

2.1. Competency definitions

Competency-based management is often presented as a strategic tool for improving organizational performance and competitive advantage by aligning human behavior with business goals. However, defining "competency" remains a point of contention across disciplines. Draganidis and Mentzas (2006) categorize competencies into three types:

a) Observable behaviors,
b) performance standards,
c) underlying personal attributes.

These viewpoints suggest that competency involves both measurable output and internal characteristics that contribute to performance.

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Spencer and Spencer (1993) define competency as: "An underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation." This emphasizes that competencies are predictive, stable, and integral to job success. Table 1 summarizes additional definitions by scholars such as McClelland (1973), Boyatzis (1982), and Marrelli (1998), who have variously highlighted knowledge, skills, attitudes, and personal values.

Table 1: Definitions of the competency concept.

Source	Definition	Key Focus
McClelland (1973)	Competency refers to a complex construct that includes a range of individual characteristics, including motives, traits, self-concepts, attitudes or values, content knowledge, and cognitive behavior skills. These characteristics can be reliably measured or quantified and have been shown to distinguish superior from average performers.	Motives, traits, values, cognitive skills
Boyatzis (1982)	Competencies are fundamental attributes of an individual that exhibit a causal relationship with effective job performance, wherein a change in one variable leads to a change in another.	Individual attributes, causal link to performance
UK National Vocational Council for Vocational Qualification (1997)	Competency is defined as the set of performance standards that enable individuals to effectively carry out their work roles or job functions to the level of proficiency required in their respective employment settings.	Performance standards, job functions
Marrelli (1998)	Competencies refer to quantifiable human abilities that are necessary for meeting the demands of efficient job performance.	Abilities, measurable skills
Dubois (1998)	Competencies refer to a set of attributes, including knowledge, skills, mindsets, and thought patterns, that enable individuals to achieve successful performance when utilized either independently or in combination.	Knowledge, skills, mindsets
Treasury Board of Canada Secretariat (1999)	Competencies refer to the collection of knowledge, skills, abilities, and behaviors that an employee utilizes in the execution of their work. These competencies serve as crucial employee-related mechanisms for attaining outcomes that align with the organization's business strategies.	Knowledge, skills, behaviors, organizational alignment
Selby et al. (2000)	Competency can be defined as a manifestation of ability through observable behavior.	Observable behavior
Intagliata et al. (2000)	At its core, competencies offer organizations a means to articulate the behavioral requirements for their leaders to achieve desired outcomes while also fostering and reinforcing the organization's culture. Leaders at all levels ought to be provided with a guiding principle, commonly referred to as the ‚North Star', to effectively steer their actions towards achieving greater synergy and generating more substantial and uniform outcomes.	Leadership behaviors, organizational culture
Jackson and Schuler (2003)	The term „competencies" refers to a set of skills, knowledge, abilities, and other attributes that are necessary for an individual to effectively carry out a particular job.	Skills, knowledge, abilities

Despite their conceptual richness, these definitions vary in emphasis, challenging the creation of cohesive frameworks, particularly in highly technical fields. This definitional variability poses a fundamental issue for building competency-based models in engineering project performance.

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2.2. Competencies and work performance

A significant body of literature links competencies to job and project performance. Savković et al. (2022) contrasted the emphasis on communication, cooperation, and leadership in agile project management with the technical focus of traditional approaches. Gruden and Stare (2018) and Majeed et al. (2022) suggested that leadership and communication significantly impact project outcomes. Stubbs Koman and Wolff (2008) and Müller and Turner (2010) underscored the role of emotional intelligence in enhancing team efficacy. Multiple studies employ surveys and questionnaires to assess the competencies of project managers and their influence on business innovation and entrepreneurship (Martín-Rojas et al., 2013; Akinshipe et al., 2022; Moradi et al., 2020). Chung and Wu (2011) identified strategic thinking and communication as essential for HR leaders. Ekrot et al. (2016) showed that perceived organizational support and skill development improve project performance, client satisfaction, and profitability. Starkweather and Stevenson (2011) suggested that while certifications, such as PMP, hold value, they are insufficient without additional soft skills.

Mixed-methods research was utilized in the studies conducted by Dobrowolski et al. (2021), Loufrani- Fedida and Missonier (2015), Ortiz-Marcos et al. (2013), and Hopkins and Bilimoria (2008). Korzynski et al. (2021) found that leaders that are politically knowledgeable and flexible are better able to overcome a wide range of obstacles. Each of these investigations incorporated interviews with managers in their data collection. In these research articles, the value of competencies in a variety of business domains was investigated through the use of a mix of interviews, questionnaires, and literature reviews. However, these studies often lack detailed methodology, limiting their replicability.

Collectively, these findings underscore the multi-dimensional nature of competencies. Yet, competency models vary across industries, and few explicitly integrate both technical and behavioral skills in relation to performance metrics.

2.3. Competency development

Many studies show that although instruments for competency development exist, their application is inconsistent. Competency growth often depends on organizational context, and there remains a gap in scalable, validated frameworks for ongoing development, particularly in engineering domains. Boyatzis (2013) introduced the Emotional and Social Competence Inventory (ESCI), a tool for assessing self- awareness and relationship management. Suhairom et al. (2014) used a mixed-methods approach to develop an IT competency model, incorporating expert interviews and surveys. Mazurchenko and Zelenka (2022) highlighted the absence of structured digital competency development in construction and automotive sectors.

Tisch et al. (2013) and Riesener et al. (2021) demonstrated the ability of competency models to enhance learning environments and resource allocation in applied contexts such as learning factories and multi- project settings. Ribeiro et al. (2021) emphasized the importance of technical, managerial, and behavioral competencies for project managers to meet the demands of Industry 4.0.

According to Herczeg and Pintér (2025), sustainability frameworks and their corresponding indicators not only offer a historical lens for understanding developmental goals but also function as operational tools for synchronizing strategic and competency-based performance management systems. Németh et al. (2023) emphasized this perspective by identifying institutional obstacles—such as disjointed methods and inadequate stakeholder engagement—that frequently impede such alignment in both educational and industrial settings. In addition, the success of such frameworks often depends on the motivations and behavioral intentions of individual participants, as demonstrated by Vinkóczi et al. (2024), whose research highlights the role of internalized values in shaping sustainability engagement, including zero-waste practices that can affect wider organizational behavior.

2.4. Competencies in the automotive sector

The studies conducted by Huhtala (2023), Budiman et al. (2020), Johannsen (2022), and Saputra et al. (2020) emphasized the significance of possessing professional knowledge and job competencies within the engineering industry. The qualitative review conducted by Huhtala (2023) shed light on the crucial significance of both practical and theoretical education in the acquisition of essential competencies in aviation and automotive engineering. The study conducted by Budiman et al. (2020) employed the Delphi method to delineate the graduate learning competencies of automotive engineering education. The researchers identified five crucial competencies, which encompassed technical skills and knowledge of automotive engineering. Johannsen's (2022) model, known as the „Wheel of Competencies," was designed to ascertain the competencies required by the industry for research and innovation. The study revealed that technical competencies were of paramount

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importance. The research conducted by Saputra and colleagues (2020) focused on the perceptions of automotive industry managers. The investigation highlighted the significance of technical skills, communication, teamwork, and problem-solving abilities for students undertaking internships.

These findings suggest that the automotive environment values a hybrid profile: deep technical knowledge augmented by soft skills. Nonetheless, most existing models remain descriptive and lack empirical validation or alignment with performance indicators.

2.5. BEI method

The utilization of the Behavioral Event Interview (BEI) technique presents various benefits in the identification and evaluation of competencies. According to McClelland (1998) and Boyatzis (1982), BEI approach provides predictive insights by analyzing past behavior. Spencer and Spencer (1993) affirm its adaptability across professions. The methodology employed by BEI is based on the critical incident technique (Flanagan, 1954), which prioritizes the identification of particular behaviors and actions, as opposed to abstract constructs, such as intelligence or personality (Barrett & Depinet, 1991; Hogan, Hogan, & Roberts, 1996).

However, BEI is resource-intensive and susceptible to interviewer bias (Motowidlo et al., 1992; Boyatzis, 2013). While it enables personalized feedback (Caldwell & O'Reilly, 1990), it is rarely used due to its complexity. Consequently, only five articles in this review employed BEI. Fernandez (2006) expounded on the methodology and advantages of utilizing it and also provides guidance on how to conduct BEI interviews proficiently. Dreyfus's (2008) article emphasized the significance of identifying competencies through a quantitative approach to determine the most crucial competencies for R&D managers. The research revealed that effectiveness can be predicted by a combination of technical and non-technical competencies, with the management of interpersonal relationships being the most crucial competency. Dillon and Taylor (2015) employed grounded theory methodology to ascertain the behavioral competencies that are essential for information technology project managers. Their findings revealed that effective project management in IT necessitates competencies such as communication, problem-solving, and leadership. Takey and Carvalho (2015) conducted a study with the objective of creating a competency mapping model for project management in an engineering firm. The study emphasized the significance of customizing the competency mapping process to suit the distinct context and requirements of the organization. Macpherson and colleagues (2022) employed a mixed-methods research design to ascertain the nascent job classifications and corresponding proficiencies within the automotive sector in South Africa amidst Industry 4.0. The study underscores the necessity of reskilling and upskilling to equip the workforce for the emergent job categories.

Although limited in adoption, BEI holds promise for building validated, context-specific competency models, particularly in engineering and project management.

3. Methodology

This systematic literature review (SLR) was conducted following the guidelines of Kitchenham and Stuart (2007), which outline a structured, transparent, and replicable method for synthesizing existing research. The methodology consisted of planning, conducting, and reporting the review, with specific steps including the formulation of a research question, selection of appropriate databases, definition of inclusion and exclusion criteria, quality assessment, and evidence synthesis. Researchers have applied it to explore, among others, organizational sustainability perspectives (Miah et al., 2024), environmental sustainability (Bartucz et al., 2023) and the employment effects of technological development (Szabó-Szentgróti et al., 2024), which can be used to inform model-based empirical research (Gelencsér et al., 2024). This approach is aligned with the broader challenges of methodological consistency in reviewing complex constructions. Mechta et al. (2025) emphasized that the lack of defined measuring frameworks in non-financial disclosure areas underscores the necessity of systematic, replicable review processes like those applied in this study.

The research methodology encompasses both automated and manual search techniques. The research process is summarized in Figure 1 and involved the use of two comprehensive academic databases, ScienceDirect and JSTOR. The databases were selected for their broad, high-quality coverage of management, engineering, and project-related outlets that match the interdisciplinary scope of this review. Relative to other major indices (e.g., Scopus, Web of Science), ScienceDirect and JSTOR provided more consistent full-text accessibility across the target period (1999–2025) and ensured representation of both technical and managerial perspectives pertinent to automotive body development.

The search used the TITLE-ABS-KEY field, which retrieves documents containing the specified keywords in the title, abstract, or keyword sections. This ensured that any publication referring to the search term in these fields was included in the results. The applied search string was TITLE-ABS-KEY („competency" AND „project performance" AND „automotive industry"). An initial keyword "behavioral event interview" was tested but excluded from the final automated search due to its overly restrictive results. Subject areas irrelevant to the topic, such as medicine, agriculture, and veterinary sciences, were excluded.

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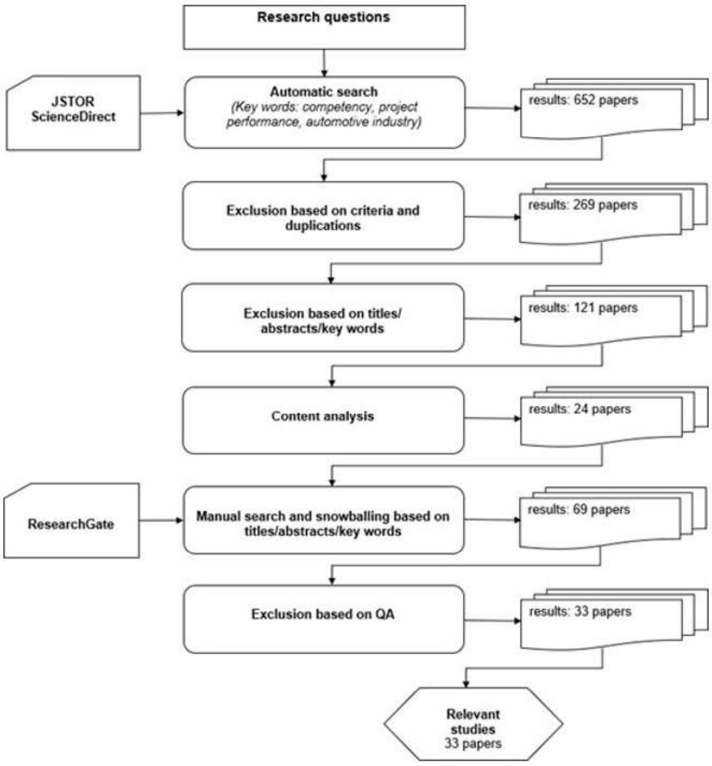

Figure 1: Results of the search and selection process

The study employed the forward and backward search approach as described by Webster and Watson (2002) to trace the gathered references of primary studies through supplementary reference scanning, commonly known as the „snowballing" method (Venesz et al., 2022). This methodology ensured comprehensive and methodical exploration, despite the initial search failing to yield pertinent literature. Utilizing a backward search methodology, a manual scan of all references cited within the present paper was performed in order to identify relevant studies that were not captured through the use of automated search techniques. In addition, the snowballing method enabled us to gather sources from databases that would have otherwise remained outside the scope of the automated search process.

As shown in Figure 1, the initial keyword-based search yielded 652 documents. After removing 11 duplicates using Mendeley, exclusion criteria, such as publication type, language, accessibility, and topic relevance, were applied, reducing the pool to 269. Further screening for thematic relevance narrowed the set to 121 studies. Following Kitchenham's (2004) guidelines, the authors documented exclusions and conducted a full-text review, identifying 24 relevant publications. An additional 45 papers were identified through manual and snowball searches on ResearchGate. After applying the same inclusion criteria and content analysis, 9 of these studies were retained in the final dataset. A total of 33 studies were selected for final analysis.

Each article included was evaluated using a six-item Quality Assessment (QA) checklist adapted from Venesz et al. (2022). To increase the researcher's trust in the general standard of the chosen articles, the quality evaluation questions were assessed for each primary study.

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Table 2 displays the six quality assurance criteria that were developed.

Code	Question
QA1	Does the research deal with the impact of competencies to work performance?
QA2	Does the research examine the automotive industry?
QA3	Does the research include the BEI method?
QA4	Is the research methodology and data collection methods, including the use of valid and reliable instruments, standardized procedures, and blinding of assessors accurate?
QA5	Are measures taken to minimize bias, including randomization, blinding, and control of confounding variables?
QA6	To what extent can the findings of the paper be generalized to other populations or settings, and can this generalizability be evaluated?

Table 2: Quality assessment criteria.

Each criterion was scored as 1 (yes), 0.5 (partially), or 0 (no). Scores ranged from 0 to 6. Articles scoring ≥5 were considered high-quality, scores between 4–4.5 were medium-quality, and ≤3.5 were considered low-quality. In total, 9 high-quality, 24 medium-quality, and 36 low-quality studies were identified. Only medium- and high-quality papers were retained for further analysis. Scores for each article are reported in Appendix A.

The search results were exported in CSV format. This file included detailed information such as author names, article titles, keywords, journal names, publication years, countries, document types, subject categories, citation counts, affiliations, and author-provided keywords. The dataset was then imported into VOSviewer to map keyword co-occurrence and thematic structure across the selected literature. VOSviewer offers three visualization options: network visualization, overlay visualization, and density visualization. The layout and clustering parameters were adjusted to suit the dataset and improve clarity of interpretation. In general, larger nodes with more connecting lines indicate greater relevance or stronger connections. Additionally, some statistical graphs were generated using Microsoft Excel.

4. Generalization of the main statements

A total of 33 articles were selected as primary sources for this systematic review. These included 24 journal articles and 9 conference proceedings. Relevant data from each study were extracted and recorded in a standardized extraction form (Appendix B), which contained the following fields: study ID, reference, key findings, research method, publication type, journal name, source database, journal ranking, and publication year (Table 3).

Table 3: Data extraction information

Data name	Description
ID	Unique identifier of the study
Reference	The title and name of the authors of the study
Short Content	The key findings and description of the methods used in the study
Method	Name of the methods used in the study
Type of Paper	The type of the paper (journal article, conference proceeding, etc.)
Journal/Conference Proceeding Name	Name of the journal or conference proceeding the study was published in
Data Provider	Name of the source the study was retrieved from
Ranking of the Journal	The quartile ranking of the journal, if given
Year	Year of publication (between 1999 and 2025)

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The reviewed articles were retrieved from multiple sources, including ScienceDirect, Scopus, Emerald, Wiley, IOP, WoS, AOSIS, ARCOM, DOAJ, and MDPI. Figure 2 shows the distribution of articles by source.

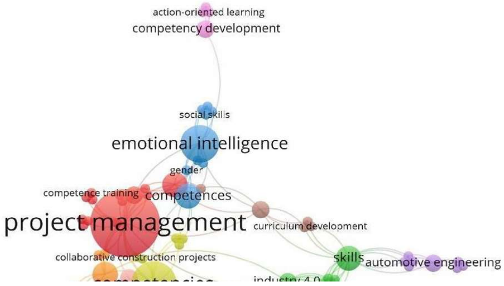

Figure 2: Numbers of articles from several providers

The methodological approaches observed in the reviewed studies were diverse, including surveys, literature reviews, case studies, and mixed methods. Notably, only five articles applied the Behavioral Event Interview (BEI) technique. Using VOSviewer, a bibliometric analysis was conducted to generate a co-occurrence keyword network (Figure 3), which revealed thematic convergence in areas, such as project management, competencies, and training, with relatively limited coverage of the automotive sector.

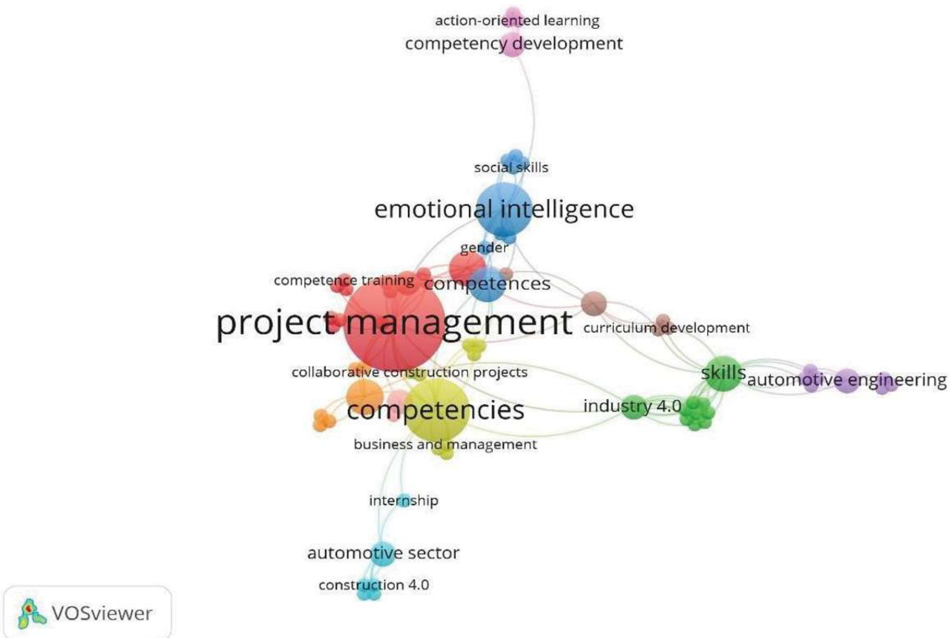

Figure 3: Network of the keywords of the primary studies

In the VOSviewer network, node size reflects the frequency of a keyword's occurrence across the corpus, while edge thickness reflects the co-occurrence strength between two keywords. The resulting articles exhibit four primary clusters, groups of keywords that tend to co-occur more frequently with each other than with the rest of the network. In the map, four clusters are observed. The first cluster of the studies explores the topic of project management and the definition of competency from a broad business management standpoint, with a strong emphasis on emotional intelligence and related soft skills, denoted by red and blue. The second cluster concentrates on the development of competency and the subject of learning, denoted by rose. The third cluster covers the responsibilities of internship and recruitment, specifically in the context of human resources management within the automotive industry, denoted by turquoise. Finally, the fourth cluster explores the correlation between automotive engineering and skills, as well as Industry 4.0 solutions, which assume that they are primarily concerned with professional skills (purple and green).

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A brief summary of the four clusters and their representative keywords are provided in Table 4 for reference.

Table 4: Description of the clusters

Node colour	Theme	Representative keywords	Key insights for the review
Red, blue	Project management & competency definition	- project management - competencies - emotional intelligence - communication - leadership teamwork	- dominant management-driven discourse - social skill emphasis - limited direct automotive application
Rose	Competency development & learning	- competency development - curriculum - action-oriented learning - training - learning factories	- shows training modalities - scarce validation against project outcomes - informative for designing - evaluation/training pipelines
Turquoise	Internship, recruitment & automotive HR	- internship - recruitment - role fit - selection - entry-level skills - automotive sector	- HR-pipeline emphasis - sector-specific but methodologically uneven - practical touchpoints with limited outcome linkage
Green, purple	Automotive engineering & Industry 4.0	- automotive engineering - industry 4.0 - digital skills - data - automation	- most recent emphasis - automotive-specific evidence still thin prime target - KPI-anchored validation

The clusters may also be categorized chronologically; this is illustrated in Figure 4.

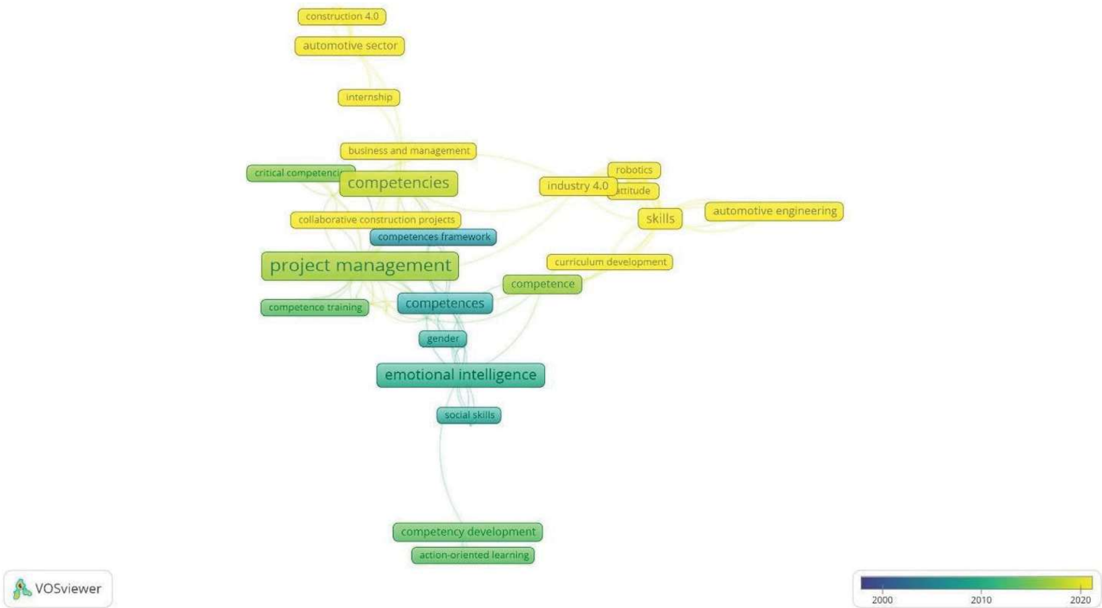

Figure 4: Chronological map of the primary studies by keywords

Figure 4 displays the chronological development of topics by keyword analysis. Articles from 2000–2010 primarily explored basic competency frameworks and project management. In contrast, studies published after 2010 focused more on competency development. The two remaining clusters, which pertain to the investigation of new industrial solutions and the automotive sector, represent the most current research in this field. Both visual representations demonstrate an obvious lack of correlation between basic competency theories and performance within the automotive sector.

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As such, the systematic literature review serves to validate the existence of this research gap. In line with this interpretation, Table 5 summarizes the four thematic clusters by timeline (2000–2010, 2011–2015, 2016–2020, 2021–2025) to make their temporal distribution more transparent.

Table 5: Thematic clusters over time (2000–2025).

Timeframe	Label	Clusters (Emphasis)
2000–2010	Foundational competency frameworks	Project management & competency definition, Competency development & learning
2011–2015	Performance discourse & PM profiles	Project management (links to performance discourse), Internship & recruitment
2016–2020	Industry 4.0 & digital skills expansion	Automotive engineering & Industry 4.0, Competency development & learning (strong growth, learning factories)
2021–2025	Hybrid models & behavior-based assessment	Project management & competency definition (calls for hybrid framing), Competency development & learning (refinement; micro-modules/blended learning)

Across the clusters, three major patterns emerged:

- A persistent disconnect between general competency theories and performance outcomes in engineering or automotive settings;
- Minimal integration of BEI methodology despite its relevance for identifying practical, job- based competencies;
- A lack of validated models linking individual competencies with measurable project KPIs. Although many studies highlight the importance of soft skills, such as communication and leadership, the majority of frameworks continue to be descriptive and lack sector specificity. Research on the automotive sector is particularly underrepresented, and body development as a technical subfield is entirely absent.

In summary, the 33 studies reviewed confirm the strategic relevance of competency assessment for improving project outcomes, talent management, and employee development. However, the current literature does not sufficiently capture the interaction between individual competencies and performance in engineering environments. This justifies the need for integrated frameworks that can accommodate both technical and behavioral factors in future research and practice.

5. Discussion

The findings of this review highlight a number of important implications for the theory and practice of competency-based frameworks in engineering and automotive environments. First, the majority of the literature focuses on generic project management competencies without establishing strong empirical links to project performance indicators. This suggests that although competencies, such as leadership, communication, and emotional intelligence, are widely recognized, their role in performance outcomes remains under-theorized and under-validated, particularly in technical fields.

The review also confirms the underutilization of structured methods like the Behavioral Event Interview (BEI), despite their capacity to identify job-relevant competencies. This may be due to resource- intensiveness and the dominance of quantitative survey-based approaches. However, the few studies that implemented BEI show promise in connecting behavioral insights to practical project outcomes, indicating that future research should consider combining BEI with performance metrics to explore causal mechanisms. In our present doctoral research, BEI benefited from domain-literate interviewing. The lead researcher's extensive expertise in automotive body engineering facilitated effective technical communication, clear identification of essential events, and proper clarification of engineering language. Consequently, narratives were translated into codable competencies with enhanced accuracy, minimizing typical sources of distortion and decreasing interpretive variability during coding. The research experience suggests that domain familiarity is a necessary condition for implementing BEI in engineering-centric environments. However, it must also be supplemented by defined protocols, double-coding, and explicit reporting of inter-rater reliability to harmonize the benefits of insider knowledge with the demands of transparency and rigor.

Furthermore, the literature shows a persistent gap in the integration of technical and behavioral competencies into a unified framework. Most reviewed models treat soft and hard skills separately, which reduces their applicability in practical

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engineering contexts, where such competencies often interact dynamically. This fragmentation restricts the efficacy of competency models for tasks like recruitment, training, and performance assessment.

The automotive sector, while included in several studies, remains largely underrepresented. In particular, there is a significant lack of research linking competencies to measurable performance in subdomains such as vehicle development. This indicates a missed opportunity for industry-specific frameworks that align with the technological and collaborative demands of modern engineering projects.

The results also point to a temporal evolution in competency research. While early studies emphasized general frameworks and managerial roles, more recent work reflects growing interest in industry-specific, digital, and hybrid competencies relevant to Industry 4.0. However, even these recent contributions tend to prioritize operational optimization over the human aspect of project performance.

Overall, the findings underscore the need for more comprehensive, empirically validated, and context- specific competency models. Future research should focus on empirically testing the correlation between competencies and project performance indicators (KPIs) within engineering domains. Moreover, there is

an increasing necessity to investigate hybrid frameworks that combine both technical and behavioral aspects of competency. It is very advisable to integrate qualitative techniques, such as Behavioral Event Interviewing (BEI), with quantitative methods to attain more profound insights and wider applicability. Finally, developing domain-specific competency models tailored to underexplored fields, such as automotive body engineering, represents a promising direction for future investigation.

6. Limitations

The study is not without limitations. As Sparrow (1995) and others have noted, the lack of definitional consensus in competency-based research can lead to conceptual ambiguity. This may result in confusion when selecting or prioritizing competencies for specific roles. Additionally, many existing approaches rely heavily on subjective assessments, such as self-reported surveys or managerial opinion, which may introduce bias and reduce generalizability. This issue extends to behavior-based methodologies; although Behavioral Event Interviews (BEI) yield more substantial evidence than self-reports, they are resource- demanding and reliant on the interviewer. In the absence of standardized coding, interpretive drift may arise, while the varying methodological rigor of competency identification tools further constrains both the comparability of findings and their practical application.

Another limitation lies in the scope of the literature included. While this review focused on peer-reviewed academic publications, it excluded grey literature, technical reports, and industry white papers that might offer valuable practical insights. Also, most studies originate from Europe and North America, limiting geographic diversity. Cultural differences in perception, execution, and recognition of competencies may influence their prominence across contexts. As a result, findings derived from Western OEM environments may over-represent “Western-coded” competencies while neglecting patterns common in other regions. This is particularly relevant for automotive body development, where cross-border collaboration and decentralized engineering are standard; competencies that forecast interface management or gate readiness in one cultural context may manifest differently in another. The original research agenda intended to investigate cultural effects by contrasting Western contexts with Asian supplier workforces. However, the necessary multi-site access, translation and calibration of instruments (e.g., BEI codebooks), and representative sampling proved impractical within the scope of a single doctoral project. This study is limited to peer-reviewed sources and clearly indicates geographic bias. Moreover, the prioritization of cross- regional, multilingual, and measurement-invariance-tested strategies would be beneficial for future, larger- scale research.

Finally, despite using both automated and manual search strategies, some relevant works may have been inadvertently omitted due to limitations in database coverage, delays in indexing, or variations in keywords. The methodological variability in competency identification techniques among research (including measurement equipment, thresholds, and reporting standards) restricts direct comparability and may hinder the practical applicability of results to automotive programs.

Despite these limitations, the study adhered to a rigorous systematic review methodology using the Kitchenham and Stuart (2007) protocol, supported by a quality assessment process and bibliometric analysis through VOSviewer. These steps helped ensure transparency, reproducibility, and analytical depth.

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7. Conclusion

This study synthesized 33 peer-reviewed articles spanning from 1999 to 2025 to examine the application of competency-based frameworks within engineering contexts, with a focus on the automotive sector. The results underscore the complex nature of competencies, particularly the interplay between technical and behavioral skills in determining project performance. Despite widespread recognition of soft skills like leadership and communication, few models integrate them effectively with technical competencies.

The review revealed significant thematic gaps, particularly in the underrepresentation of the automotive sector and the absence of validated frameworks linking competencies to project KPIs. Moreover, while tools like the Behavioral Event Interview (BEI) offer potential for capturing real-world competencies, their use remains limited.

Regarding RQ1, the evaluation does not provide a conclusive answer. The evidence base is disjointed, classifications and analytical levels are varied, and the automotive body development subdomain is inadequately represented. Therefore, the review can merely identify a pool of commonly referenced competencies and outline their distribution, without establishing a definitive or prioritized set.

Concerning RQ2, the review outlines evaluation methodologies transcend mere dependence on credentials or self-assessment. These include standardized, domain-specific Behavioral Event Interviews (BEI); structured scoring rubrics and codebooks; coder training and calibration; and the incorporation of independent project artifacts (e.g., PLM logs, change notices, gate review minutes) to contextualize behavioral evidence within verifiable workflows. The study serves as a navigational tool and a compilation of methodologies, rather than a definitive answer to the research questions posed.

This review not only synthesizes diverse findings but also provides a practical framework for implementation. It further clarifies terminology and delineates methodological options that can reliably elicit behavior in engineering contexts. Within the broader research program, these insights are being translated into a BEI-informed, hybrid framework encompassing behavioral characteristics and technical expertise, which are evaluated for efficacy against independent project records. The combined approach of literature synthesis and empirical testing demonstrates the translation of evidence into competency-based practices, facilitating more justifiable hiring and advancement decisions, focused training and development, and more dependable project resourcing while also establishing a cohesive framework for further empirical enhancement.

The research indicates that definitional variety and dependence on subjective measures limit comparability. Additionally, the geographic concentration of studies in Europe and North America complicates generalizability, particularly when cultural norms influence the perception and enactment of competencies. The authors advocate for mixed-methods, longitudinal, and multilevel designs, extensive geographic sampling with measurement-invariance assessments, and clear reporting requirements, including pre- specified codebooks, double-coding, and inter-rater reliability.

Future research should prioritize the development and empirical validation of hybrid competency models to address these deficiencies. These models should consider sector-specific requirements, incorporate both soft and hard skills, and be validated against measurable performance metrics. Research should include a broader range of methodologies, integrating qualitative and quantitative approaches, while also extending its geographic and industrial scope.

In conclusion, improving engineering project performance necessitates a transition from fragmented, generic frameworks to integrated, evidence-based models. These models can more efficiently capture the interaction between technical and behavioral aspects. They also establish a more robust foundation for matching competencies with project results in complex environments like automotive engineering. This review establishes a theoretical foundation for the authors´ doctoral research. The subsequent phases enhance it by implementing a hybrid, BEI-informed model and evaluating its validity in project situations.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix A Quality assessment scores

ID	QA1	QA2	QA3	QA4	QA5	QA6	SUM	Quality
S1	0	0	0	0,5	1	0	**1,5**	**low**
S2	0	0	0	1	1	1	**3**	**low**
S3	0	0	0	1	0,5	1	**2,5**	**low**
S4	0	0	0	1	1	1	**3**	**low**
S5	0	0	0	1	1	0,5	**2,5**	**low**
S6	0	0	0	1	1	0,5	**2,5**	**low**
S7	0,5	0	0	0,5	1	1	**3**	**low**
S8	1	0	0	1	1	1	4	medium
S9	0	0	0	1	1	1	**3**	**low**
S10	0	0	0	1	1	1	**3**	**low**
S11	1	0	0,5	1	1	1	**4,5**	**medium**
S12	0	1	0	1	1	0,5	**3,5**	**low**
S13	0	1	0	1	1	0	**3**	**low**
S14	0,5	0	0	1	1	0,5	**3**	**low**
S15	1	0	0	1	1	1	**4**	**medium**
S16	0	1	0	1	1	0,5	**3,5**	**low**
S17	0	1	0	1	1	0	**3**	**low**
S18	0,5	0	0	1	1	1	**3,5**	**low**
S19	0	0	0	1	1	1	**3**	low
S20	0,5	1	0	0,5	1	0,5	**3,5**	**low**
S21	0	0	0	1	1	1	**3**	**low**
S22	0	1	0	1	1	0	**3**	**low**
S23	0	0	0	1	1	0,5	**2,5**	**low**
S24	0	0	0	1	1	1	**3**	**low**
S25	0	0	0	1	1	0	**2**	**low**
S26	0	0	0	1	1	1	**3**	**low**
S27	0,5	0	0	1	1	0,5	**3**	**low**
S28	0	0	0	1	1	0,5	2,5	low
S29	1	1	0	1	1	1	**5**	**high**
S30	1	1	1	1	1	1	**6**	**high**
S31	0	1	0	0,5	1	0	**2,5**	**low**
S32	1	0	0	1	1	1	**4**	**medium**
S33	1	0	0	1	1	1	**4**	**medium**
S34	1	1	0,5	1	1	0,5	**5**	**high**
S35	1	1	0	1	1	0,5	**4,5**	**medium**
S36	1	0	0	1	1	1	**4**	**medium**
S37	1	0	0	1	1	1	**4**	**medium**
S38	1	0	0	1	1	1	**4**	**medium**
S39	1	1	0	1	1	0,5	**4,5**	medium
S40	1	0	0	1	1	1	**4**	**medium**
S41	1	0	0	1	1	1	**4**	**medium**
S42	1	0	0	1	1	0	**3**	**low**
S43	0	1	0	0,5	1	0,5	**3**	**low**
S44	0	0	0	1	1	0,5	**2,5**	**low**
S45	1	0	1	1	1	0,5	**4,5**	**medium**

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Appendix A (Continued)

ID	QA1	QA2	QA3	QA4	QA5	QA6	SUM	Quality
S46	1	0	0	1	1	1	**4**	**medium**
S47	1	0	0	1	1	1	**4**	**medium**
S48	1	0	1	1	1	0,5	4,5	medium
S49	1	0	0	0,5	1	0,5	**3**	**low**
S50	1	0	1	1	1	1	**5**	**high**
S51	1	1	1	1	1	0,5	**5,5**	**high**
S52	0,5	0	0	0,5	1	0,5	**2,5**	**low**
S53	1	0	0,5	1	1	1	**4,5**	**medium**
S54	1	1	0,5	1	1	0,5	**5**	**high**
S55	1	0	0	1	1	1	**4**	**medium**
S56	1	0	0	1	1	1	**4**	**medium**
S57	1	0	0	1	1	1	**4**	**medium**
S58	1	0	0	0,5	1	0,5	**3**	**low**
S59	1	1	0	1	1	1	**5**	high
S60	1	0	0	1	1	1	**4**	**medium**
S61	1	0	0	1	1	1	**4**	**medium**
S62	1	0	0	1	1	0	**3**	**low**
S63	1	1	0	1	1	0,5	**4,5**	**medium**
S64	1	0	0	1	1	0	**3**	**low**
S65	1	1	0	1	1	1	**5**	**high**
S66	1	1	0	1	1	0,5	**4,5**	**medium**
S67	1	1	0	1	1	1	**5**	**high**
S68	1	0	0	1	0,5	1	**3,5**	**low**
S69	0	1	0	0,5	1	0	**2,5**	**low**