Management Systems
in
Production Engineering

2026, Volume 34, Issue 3, pp. 348-361

Date of submission of the article to the Editor: 12/2025
Date of acceptance of the article by the Editor: 07/2026

DOI 10.2478/mspe-2026-0033

MANAGING IMPROVEMENT PROJECTS UNDER CONTINUOUS IMPROVEMENT: PRACTICES, PORTFOLIOS, AND FAILURE FACTORS – EVIDENCE FROM POLISH INDUSTRY

Aneta Kucińska-Landwójtowicz, Izabela Czabak-Górska
Opole University of Technology

Abstract:
The study investigated the role and effectiveness of improvement projects (IPs) which have been implemented within the Continuous Improvement (CI) framework in Polish manufacturing companies. Although CI practices are widely recognized worldwide, little is known about how such projects are organized and managed in Poland. A survey has been conducted using computer-aided telephone interviewing (CATI) among 70 managers and quality specialists from manufacturing firms to address this gap. The research examined the types and frequency of IPs, project management methodologies (PMMs), the presence of project portfolios, and the impact of critical failure factors (CFFs) on project outcomes. The results show that projects focused on quality, efficiency, and waste reduction are the most common, whereas Six Sigma and 5S initiatives are less frequently applied. Organizations with higher CI maturity tend to engage more actively in improvement projects and use PMMs more consistently. In practice, tool-based approaches, such as project schedules or charters, are preferred over more formalized methodologies, like PMI or PRINCE2. The findings also reveal that operational barriers – especially insufficient engagement of project leaders – undermine the success of CI initiatives. This research offers the first empirical evidence on CI-related projects in Polish manufacturing, highlighting both enablers and barriers, and provides practical recommendations for managers seeking to strengthen the strategic impact of their improvement efforts.

Key words: continuous improvement, improvement projects, project management methodologies, project portfolio, manufacturing industry, failure factors

INTRODUCTION

One of the key concepts widely applied in manufacturing organisations is continuous improvement (CI), which, similar to Kaizen, is regarded as a fundamental basis for enhancing productivity across all organisational levels [1]. CI **–** currently viewed as a philosophical management style, process, and method **–** demands the simultaneous application of soft and hard factors [2]. CI is often associated with methods such as Lean Management, Lean Production, Six Sigma, and Lean Six Sigma, or as a link to the concept of quality management, which is discussed, among others, in works [3, 4, 5]**.** One of the key elements of CI is a set consisting of implementation, extension [6], selection, and management [7] of an improvement project (IP) that allows for the introduction of changes and the achievement of assumed goals in an organized and systematic manner. An improvement project is defined as a unique undertaking aimed at enhancing the organization and its processes, consisting of a sequence of interrelated and completed activities [8, 9].

Modern management in manufacturing companies requires a continuous response to environmental changes, the adoption of new operational approaches, and the improvement of processes. The contemporary business environment presents organizations with numerous challenges arising from increasing global competitiveness, environmental turbulence, the need for sustainable development, as well as social and demographic changes. In manufacturing companies, both production and project management are increasingly shaped by the principles of Industry 4.0, including digitalization, automation, advanced data analytics, and the integration of cyber-physical systems. These developments are further accompanied by the growing role of artificial intelligence, cybersecurity challenges, risk analysis, and the need to build resilient management systems. Consequently, organizations face a continuous need for transformation and the systematic search for innovative solutions within enterprise processes.

Process IPs represent a systematic method for enhancing organizational outcomes, relying on defined tools, techniques, and technologies applied within coordinated improvement efforts [10]. Regarding the subject being analyzed, examining the approaches adopted in managing IPs is particularly relevant. An essential aspect of this inquiry is to determine which classical project management methodologies are applied and to what extent. As highlighted in the literature, classical approaches to project management continue to be widely implemented in practice, e.g., PRINCE2 and the PMI-PMBOK Guide standard [11] (in stable project environments), SCRUM (in uncertain project environments) – agile methodologies [12]. Considering approaches focused on CI, project management is frequently supported by techniques such as DMAIC [13] and PDCA [14]. For managing small- to medium-scale projects, it is advisable to appoint a project leader, prepare a project charter, and develop a project schedule. Project planning, scheduling, and control have a significant impact on success across various industries and countries [15]. Building on these perspectives, it is also important to broaden the analysis toward project portfolio management (PPM), which provides a strategic framework for aligning multiple projects with organizational objectives and ensuring the effective allocation of resources across the entire portfolio. In the case of improvement projects, poor project selection is often viewed as a significant obstacle to implementing CI.

In contrast, project selection is a critical success factor [16]. To fully leverage the potential of CI in manufacturing companies, it is essential to identify and understand the success factors and the barriers that hinder its implementation and application. Critical success factors related to improvement projects have been explored in relation to Lean [17], Six Sigma projects [18], and Quality Circles and Kaizen Events [19]. Although research indicates the critical role of CI in the development of companies [20, 21, 22], researchers also point out the obstacles which hinder the implementation of this concept. In prior studies, researchers identified numerous organizational, managerial, and behavioral barriers that obstruct the effectiveness of CI initiatives. McLean and Antony, as well as McLean [23, 24], conceptualized these barriers within a multi-stage framework. Other authors have documented recurring shortcomings related to leadership, communication, training, and project governance in Lean and Six Sigma contexts [23]. International studies also report diverse sets of Critical Failure Factors (CFFs) across countries and CI approaches [24, 25, 26], highlighting the persistent challenges organizations face in sustaining improvement efforts. Sanchez and Blanco [3] note that CI research shows apparent regional variation. Empirical studies conducted in Europe, the Americas, Asia, and the Middle East [24, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36] confirm that the adoption of CI and its outcomes depend strongly on organizational and national contexts. Comparative analyses of CI failure factors across countries, such as the USA, the UK, China, and India [27], further highlight these contextual differences. Additional work has examined success catalysts for Kaizen implementation in specific sectors, including construction [37]. Despite this broad international evidence, the implementation of IPs within CI has not been comprehensively examined in Polish manufacturing firms. There is a lack of empirical studies addressing the types and frequency of IPs, the degree of formalization in PM practices, and the existence of CI-oriented project portfolios. This study addresses these gaps by analyzing the role, structure, and perceived effectiveness of IPs in manufacturing organizations operating under CI principles.

In line with these objectives, the following research questions have been formulated:

RQ1. What types of IPs are being conducted, and what is their frequency, in manufacturing organizations implementing CI?

RQ2. To what extent are specific project management methodologies applied in IPs within manufacturing companies implementing CI?

RQ3. To what extent do manufacturing organisations, which are implementing CI, establish an improvement project portfolio?

RQ4. What is the perceived impact of selected factors on the lack of effectiveness of improvement projects in manufacturing companies, which implement CI?

RESEARCH METHODOLOGY

The aim of the study has been to assess the role, structure, and perceived effectiveness of improvement projects (IPs) implemented within Continuous Improvement (CI) practices. The research has been conducted using a quantitative methodology, supported by computer-aided telephone interviewing (CATI). This method was selected for its efficiency in reaching a geographically dispersed group of manufacturing companies within a limited time. A purposive sampling strategy was applied, targeting organizations that declared the use of CI practices. The survey instrument was developed using a cascade model and had been preceded by a pilot test conducted among manufacturing companies. The pilot's aim was to verify the reliability and clarity of the questionnaire, particularly the structure and comprehensibility of the items. The validated version of the questionnaire consisted of four main thematic blocks, each containing closed-ended questions or rating-scale items. Specific questions regarding the types of IPs (IPTP1-IPTP6) and the project management methodologies (PMM1-PMM8) which were used, had been formulated based on literature sources [5, 38]. In contrast, questions related to CFFs (CFF1-CFF13) and the effects of CI (IAE1-IAE13) were developed basing on studies [23, 24, 26, 39]. It should be emphasized that respondents identified a broad spectrum of PMMs, including advanced project management methodologies (PMM 1-3), less formalized approaches (PMM 4-5), as well as basic techniques supporting the organization of project activities (PMM 6-8). The aim was to determine the extent to which these solutions are applied in manufacturing companies to manage improvement projects of varying scope and complexity. Additional literature was also consulted in developing the research questions [4, 31]. An overview of the research procedure is shown in Fig. 1.

The empirical study was conducted among 70 respondents representing Polish manufacturing companies. Participants had been purposively selected by their organizations as individuals responsible for or directly involved in improvement initiatives. The sample consisted predominantly of quality managers (37.1%), followed by senior managers, project leaders, coordinators, and quality experts (25.7%), as well as management system officers (8.6%) and members of top management (2.9%). Most respondents (84%) were employed in medium-sized companies (50-249 employees), while 10% represented small companies (10-49 employees) and additionally 6% originated from large enterprises (over 250 employees). In terms of industrial sectors, the electro-mechanical industry – including metal, machinery, precision, transport equipment, electrical, and electronics companies – was the most represented (40%). Other sectors included wood and paper (30%), food (20%), and cosmetics (10%).

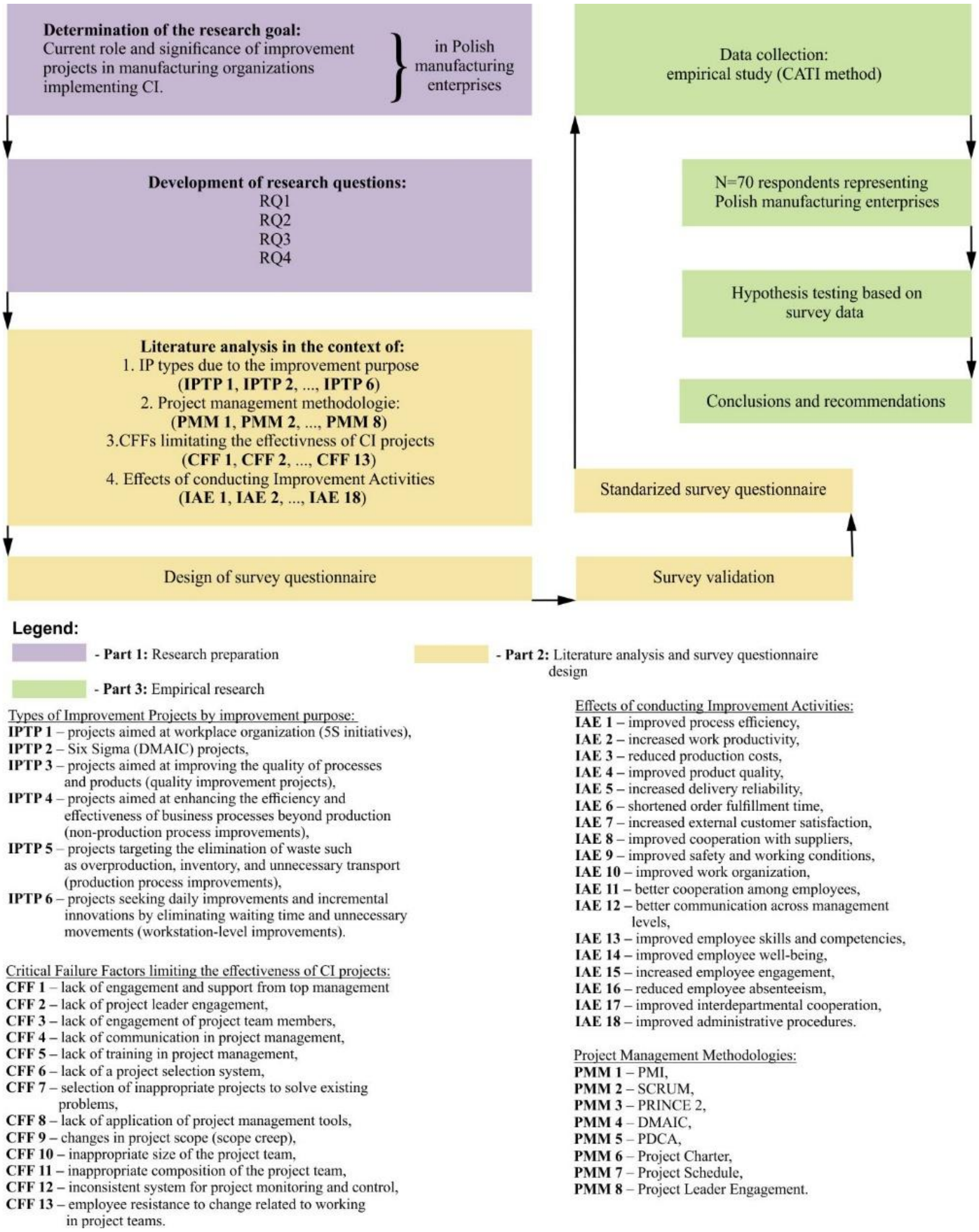

Fig. 1 Scheme and Procedure of the Conducted Research

Alt text: *flowchart of the research procedure: preparation, literature analysis, questionnaire design, and a CATI study involving 70 respondents.*

Long description: *the research procedure consists of three stages. First, the research goal and four research questions are defined. Second, literature analysis identifies six types of improvement projects, eight project management methodologies, thirteen critical failure factors, and eighteen effects of improvement activities. These categories are used to design and validate a standardized survey questionnaire. Third, CATI data are collected from 70 respondents representing Polish manufacturing enterprises. The survey data are used to test hypotheses, followed by conclusions and recommendations.*

The questionnaire included a series of questions grouped according to specific research hypotheses (HRQ), each addressing a distinct area of analysis. To answer the research questions posed in the introduction, a set of 10 hypotheses was formulated (HRQ1a-HRQ4b), as shown in Table 1.

Table 1
Review of formulated research hypotheses for the research questions posed, with appropriate statistical methods

Hypothesis		Statistical test
RQ1. What types of Improvement Projects are being conducted, and what is their frequency, in manufacturing organizations that implement Continuous Improvement?		
HRQ1a	The frequency of the implementation of improvement projects differs depending on the project type.	Friedman + Durbin-Conover (Post-Hoc)
HRQ1b	Improvement projects focused on process quality are implemented more frequently than workplace organization (5S) projects.	Wilcoxon for paired samples (right-tailed)
HRQ1c	A high level of CI maturity in an organization has been shown to correlate with a higher frequency of Improvement Projects.	Spearman (right-tailed)
RQ2. To what extent are specific project management methodologies applied in improvement projects within manufacturing companies implementing Continuous Improvement?		
HRQ2a	In organizations characterized by a higher level of CI maturity, there is a greater prevalence of project management methodologies.	Spearman (right-tailed)
HRQ2b	The frequency with which project management methodologies are applied in improvement projects varies depending on the type of methodology.	Friedman + Durbin-Conover (Post-Hoc)
HRQ2c	Organizations that use project management methodologies tend to report higher levels of effectiveness in their continuous improvement projects.	Spearman (right-tailed)
RQ3. To what extent do manufacturing organizations implementing Continuous Improvement establish an improvement project portfolio?		
HRQ3a	Organizations with higher levels of CI maturity tend to develop a more extensive portfolio of improvement projects.	Spearman (right-tailed)
HRQ3b	Organizations that more frequently utilize project management methodologies tend to build portfolios of improvement projects more systematically.	Spearman (right-tailed)
RQ4. What is the perceived impact of selected factors on the lack of effectiveness of improvement projects in manufacturing companies implementing Continuous Improvement?		
HRQ4a	The perceived impact of critical failure factors on the effectiveness of improvement projects varies depending on the type of factor.	Friedman + Durbin-Conover (Post-Hoc)
HRQ4b	The perceived effectiveness of continuous improvement projects varies depending on the perceived influence of the project leader's disengagement.	Kruskal-Wallis

To analyze the dataset, both descriptive and inferential statistics were applied because the variables failed to meet normality assumptions. Nonparametric tests at the significance level of α = 0.05 were used, including the Friedman test, Wilcoxon signed-rank test. Durbin-Conover post-hoc tests were applied for pairwise post-hoc comparisons, and the resulting p-values were adjusted using the Holm-Bonferroni method, which provides greater statistical power than the Bonferroni correction while maintaining control over the family-wise error rate. Associations between variables were examined using Spearman's rho correlation. This analytical strategy enabled the identification of patterns in project practices and the perception of barriers in order to effectuate project management. Most items were measured using Likert-type or frequency scales. All statistical analyses was conducted by the authors using Jamovi 2.6.44. During the preparation for this work, the authors used ChatGPT (OpenAI, GPT-5 version) and Grammarly in order to improve linguistic clarity, grammatical correctness and overall readability. After using these tools, the authors reviewed and edited the content as required and lastly took full responsibility for the publication's content.

RESULTS AND DISCUSSION

The results of the statistical analyses conducted to verify hypotheses HRQ1-HRQ4 are summarized in Table 2.

Table 2

Results of hypothesis testing (HRQ1-HRQ4): project improvement implementation, project management methodologies, portfolios, and critical failure factors

Results of the statistical tests

Types and frequency of Improvement Projects implementation

HRQ1a Friedman: $\chi^2 = 49.8$, $df = 5$, $p < .00$ Durbin-Conover (Post-Hoc) with Holm correction:

Pairwise value	*D-C statistic*	*p value*	α_{adj}	*Pairwise value*	*D-C statistic*	*p value*	α_{adj}
IPTP 5-IPTP 6	1.327	.185	.010	***IPTP 6-IPTP 1***	4.091	<.001	.005
IPTP 5-IPTP 4	1.852	.065	.008	***IPTP 4-IPTP 3***	.276	.782	.050
IPTP 5-IPTP 3	2.129	.034	.007	***IPTP 4-IPTP 2***	5.225	<.001	.004
IPTP 5-IPTP 2	3.372	<.001	.006	***IPTP 4-IPTP 1***	4.616	<.001	.004
IPTP 5-IPTP 1	2.764	.006	.006	***IPTP 3-IPTP 2***	5.501	<.001	.004
IPTP 6-IPTP 4	.525	.600	.025	***IPTP 3-IPTP 1***	4.893	<.001	.003
IPTP 6-IPTP 3	.802	.423	.013	***IPTP 2-IPTP 1***	.608	.543	.017
IPTP 6-IPTP 2	4.699	<.001	.005				

HRQ1b Wilcoxon for paired samples (right-tailed): $W = 1198.0$, $p < .001$, $r = .0739$

HRQ1c Spearman (right-tailed) between the CI maturity level and overall project activity: $\rho_s = .313$, $p = .004$

Spearman (right-tailed) between the CI maturity level and the specified project activity:

IP types	ρ_s	*p value*	*IP types*	ρ_s	*p value*
IPTP 6	.306	.005	***IPTP 3***	.358	.001
IPTP 5	.223	.031	***IPTP 2***	.290	.007
IPTP 4	.307	.005	***IPTP 1***	.150	.107

Application of Project Management Methodologies

HRQ2a Spearman (right-tailed) between the CI maturity level and overall methodology-use index: $\rho_s = .453$, $p = .001$

Spearman (right-tailed) between the CI maturity level and the specified PMM:

PMM types	ρ_s	*p value*	*PMM types*	ρ_s	*p value*
PMM 8	.409	<.001	***PMM 4***	.419	< .001
PMM 7	.425	<.001	***PMM 3***	.270	.013
PMM 6	.477	<.001	***PMM 2***	.294	.024
PMM 5	.471	<.001	***PMM 1***	.312	.470

RQ2b Friedman: $\chi^2 = 96.1$, $df = 7$, $p < .001$

Durbin-Conover (Post-Hoc) with Holm correction:

Pairwise value	*D-C statistic*	*p value*	α_{adj}	*Pairwise value*	*D-C statistic*	*p value*	α_{adj}
PMM 1-PMM 2	.951	.342	.008	***PMM 3-PMM 5***	2.210	.028	.004
PMM 1-PMM 3	.261	.794	.050	***PMM 3-PMM 6***	5.323	<.001	.002
PMM 1-PMM 4	1.925	.055	.005	***PMM 3-PMM 7***	6.131	<.001	.002
PMM 1-PMM 5	2.472	.014	.004	***PMM 3-PMM 8***	7.058	<.001	.003
PMM 1-PMM 6	5.585	<.001	.008	***PMM 4-PMM 5***	.547	.585	.025
PMM 1-PMM 7	6.393	<.001	.009	***PMM 4-PMM 6***	3.660	<.001	.003
PMM 1-PMM 8	7.320	<.001	.002	***PMM 4-PMM 7***	4.468	<.001	.003
PMM 2-PMM 3	.689	.491	.017	***PMM 4-PMM 8***	5.395	<.001	.003
PMM 2-PMM 4	.974	.33	.007	***PMM 5-PMM 6***	3.113	.002	.004
PMM 2-PMM 5	1.521	.129	.006	***PMM 5-PMM 7***	3.921	<.001	.003
PMM 2-PMM 6	4.634	<.001	.002	***PMM 5-PMM 8***	4.848	<.001	.003
PMM 2-PMM 7	5.442	<.001	.002	***PMM 6-PMM 7***	.808	.419	.013
PMM 2-PMM 8	6.369	<.001	.002	***PMM 6-PMM 8***	1.735	.083	.005
PMM 3-PMM 4	1.664	.097	.006	***PMM 7-PMM 8***	.927	.354	.010

HRQ2c Spearman (right-tailed) between the overall methodological application index and the specified IAE:

IAE types	ρ_s	*p value*	*IAE types*	ρ_s	*p value*
IAE 18	.559	<.001	***IAE 9***	.418	<.001
IAE 17	.541	<.001	***IAE 8***	.425	<.001
IAE 16	.487	<.001	***IAE 7***	.466	<.001
IAE 15	.340	.002	***IAE 6***	.458	<.001
IAE 14	.323	.003	***IAE 5***	.303	.005
IAE 13	.361	<.001	***IAE 4***	.156	.085
IAE 12	.528	<.001	***IAE 3***	.365	<.001
IAE 11	.378	<.001	***IAE 2***	.277	.010
IAE 10	.461	<.001	***IAE 1***	.384	<.001

Improvement project portfolio

HRQ3a Spearman (right-tailed) between the level of CI maturity and the level of application of an IP portfolio: ρ_s = .515, p = .001

HRQ3b Spearman (right-tailed) between overall usage level of the PMMs and IP portfolio: ρ_s = .602, p = .001

Spearman (right-tailed) between IP portfolio and the specified PMM:

PMM types	ρ_s	*p value*	*PMM types*	ρ_s	*p value*
PMM 8	.296	.006	***PMM 4***	.519	<.001
PMM 7	.364	<.001	***PMM 3***	.506	<.001
PMM 6	.393	<.001	***PMM 2***	.492	<.001
PMM 5	.564	<.001	***PMM 1***	.487	<.001

Factors Contributing to the Lack of Effectiveness in Improvement Projects

HRQ4a Friedman: χ^2 = 20.8, df = 12, p < .053

Durbin-Conover (Post-Hoc) with Holm correction:

Parvise value	*D-C statistic*	*p value*	α_{adj}	*Parvise value*	*D-C statistic*	*p value*	α_{adj}
CFF 1-CFF 2	1.973	.049	.001	***CFF 4-CFF 11***	.144	.886	.008
CFF 1-CFF 3	1.960	.050	.001	***CFF 4-CFF 12***	2.091	.037	.001
CFF 1-CFF 4	3.032	.003	.001	***CFF 4-CFF 13***	1.385	.166	.001
CFF 1-CFF 5	2.156	.031	.001	***CFF 5-CFF 6***	.758	.449	.002
CFF 1-CFF 6	1.398	.162	.001	***CFF 5-CFF 7***	.131	.896	.010
CFF 1-CFF 7	2.026	.043	.001	***CFF 5-CFF 8***	.640	.522	.002
CFF 1-CFF 8	2.797	.005	.001	***CFF 5-CFF 9***	1.137	.256	.001
CFF 1-CFF 9	3.293	.001	.001	***CFF 5-CFF 10***	.288	.774	.004
CFF 1-CFF 10	2.444	.015	.001	***CFF 5-CFF 11***	1.019	.308	.001
CFF 1-CFF 11	3.176	.002	.001	***CFF 5-CFF 12***	1.215	.225	.001
CFF 1-CFF 12	.941	.347	.001	***CFF 5-CFF 13***	.510	.610	.002
CFF 1-CFF 13	1.647	.100	.001	***CFF 6-CFF 7***	.627	.531	.002
CFF 2-CFF 3	.013	.990	.050	***CFF 6-CFF 8***	1.398	.162	.001
CFF 2-CFF 4	1.059	.290	.001	***CFF 6-CFF 9***	1.895	.058	.001
CFF 2-CFF 5	.183	.855	.007	***CFF 6-CFF 10***	1.046	.296	.001
CFF 2-CFF 6	.575	.565	.002	***CFF 6-CFF 11***	1.777	.076	.001
CFF 2-CFF 7	.052	.958	.025	***CFF 6-CFF 12***	.457	.648	.003
CFF 2-CFF 8	.823	.411	.001	***CFF 6-CFF 13***	.248	.804	.005
CFF 2-CFF 9	1.320	.187	.001	***CFF 7-CFF 8***	.771	.441	.002
CFF 2-CFF 10	.471	.638	.003	***CFF 7-CFF 9***	1.268	.205	.001
CFF 2-CFF 11	1.202	.230	.001	***CFF 7-CFF 10***	.418	.676	.003
CFF 2-CFF 12	1.032	.302	.001	***CFF 7-CFF 11***	1.150	.250	.001
CFF 2-CFF 13	.327	.744	.004	***CFF 7-CFF 12***	1.085	.278	.001
CFF 3-CFF 4	1.072	.284	.001	***CFF 7-CFF 13***	.379	.705	.003
CFF 3-CFF 5	.196	.845	.006	***CFF 8-CFF 9***	.497	.620	.002
CFF 3-CFF 6	.562	.574	.002	***CFF 8-CFF 10***	.353	.724	.003
CFF 3-CFF 7	.065	.948	.017	***CFF 8-CFF 11***	.379	.705	.003
CFF 3-CFF 8	.836	.403	.001	***CFF 8-CFF 12***	1.856	.064	.001
CFF 3-CFF 9	1.333	.183	.001	***CFF 8-CFF 13***	1.150	.250	.001
CFF 3-CFF 10	.484	.629	.002	***CFF 9-CFF 10***	.849	.396	.001
CFF 3-CFF 11	1.215	.225	.001	***CFF 9-CFF 11***	.118	.906	.013

	CFF 3-CFF 12	1.019	.308	.001	***CFF 9-CFF 12***	2.352	.019	.001
	CFF 3-CFF 13	.314	.754	.004	***CFF 9-CFF 13***	1.647	.100	.001
	CFF 4-CFF 5	.876	.382	.001	***CFF 10-CFF 11***	.732	.464	.002
	CFF 4-CFF 6	1.634	.103	.001	***CFF 10-CFF 12***	1.503	.133	.001
	CFF 4-CFF 7	1.006	.315	.001	***CFF 10-CFF 13***	.797	.426	.002
	CFF 4-CFF 8	.235	.814	.006	***CFF 11-CFF 12***	2.235	.026	.001
	CFF 4-CFF 9	.261	.794	.005	***CFF 11-CFF 13***	1.529	.127	.001
	CFF 4-CFF 10	.588	.557	.002	***CFF 12-CFF 13***	.706	.481	.002
HRQ4b	Kruskal-Wallis' test (*df* = 2)							
	IAE types	χ^2	*p value*	ε^2	*IAE types*	χ^2	*p value*	ε^2
	IAE 18	3.213	.201	.047	***IAE 9***	7.599	.022	.110
	IAE 17	3.256	.196	.047	***IAE 8***	5.380	.068	.078
	IAE 16	2.740	.254	.040	***IAE 7***	6.004	.05	.087
	IAE 15	3.292	.193	.048	***IAE 6***	8.070	.018	.117
	IAE 14	5.220	.074	.076	***IAE 5***	6.134	.047	.089
	IAE 13	7.125	.028	.103	***IAE 4***	.291	.865	.004
	IAE 12	5.301	.071	.077	***IAE 3***	2.779	.249	.040
	IAE 11	4.230	.121	.061	***IAE 2***	6.577	.037	.095
	IAE 10	1.221	.543	.018	***IAE 1***	11.285	.004	.164

In the following sections, these results are presented and discussed in detail with respect to the corresponding research questions, focusing on differences in IP types, the use of PMMs, portfolio practices, and CFFs.

Types and frequency of Improvement Projects implementation

Responding to inquiries regarding the implementation of specific types of IPs within their respective organizations and the frequency thereof (RQ1), respondents predominantly indicated quality-focused projects (ITPT 3, 54.3%) and daily improvement opportunities (IPTP 6, 48.6%). One-third of organizations reported no use of Six Sigma (DMAIC) projects. The Friedman test (Tab. 2) confirmed significant differences in implementation frequency across IP types (HRQ1a). Durbin-Conover post-hoc comparisons with Holm correction (Tab. 2) showed that the frequency of implementation of 'Six Sigma' (IPTP 2) and '5S' (IPTP 1) differed significantly from the remaining project types, except for each other. Both project types exhibited significant pairwise differences when compared with quality-oriented projects (IPTP3), business-oriented projects (IPTP4), waste-elimination projects (IPTP5), and daily-improvement initiatives (IPTP6). Comparisons among the remaining project type pairs did not yield consistent statistically significant differences after Holm correction. Although the Friedman test indicated differences in the frequency of implementation across project types, it did not specify which types were undertaken more often. Therefore, the hypothesis based on the assumption that 'projects focused on process quality' (IPTP 3) were accomplished more frequently than projects related to 'workplace arrangement' (IPTP 1) (HRQ1b) was tested. The right-tailed Wilcoxon signed-rank test for dependent samples (Tab. 2) confirmed the hypothesis that 'quality projects' (IPTP 3) were implemented more frequently than '5S projects' (IPTP 1). This may indicate that these activities are treated as part of everyday company operations, without the need to organize projects around them. Therefore, it can be concluded that organizations differentiate the types of improvement projects they implement. Hence, the improvement strategy is diverse and is consciously selected depending on the requirements.

Afterwards, an analysis was carried out, whether a high level of CI maturity in an organization correlates with a higher frequency of improvement projects (HRQ1c). An overall project activity index was calculated by averaging responses across all project types (IPTP 1-IPTP 6). A right-sided Spearman's rank correlation (Tab. 2) analysis indicated a low but significant positive relationship between the CI maturity level and an overall project activity, indicating that more mature organizations undertake improvement projects more frequently. Project-specific analyses for particular project types (IPTP 1-IPTP 6) revealed similarly positive and statistically significant correlations for most project types. However, their strength remained low correlations for most projects types ($\rho_s \geq .02$, $p < .05$). The strongest associations were observed for quality-oriented projects (IPTP3), projects involving changes outside the production area (IPTP4), and waste-elimination projects (IPTP5). No significant relationship was found for 5S-related projects (IPTP1). These findings suggest that higher CI maturity fosters more systematic and tool-intensive improvement initiatives, particularly those linked to operational and quality-related outcomes.

Application of Project Management Methodologies

Most respondents (81%) reported using project management methodologies when implementing improvement activities (RQ2). Over one-third of companies (37%) apply these methodologies to large projects, while 19% use them for all improvement initiatives. The use of project methodologies correlates increasingly with CI maturity, from 0% maturity at level 1 to 100% at level 5. At lower maturity levels, methodologies are applied sporadically or only in major projects, whereas mature organizations use them systematically across both large and smaller improvement efforts. This suggests that formalized project management becomes an integral component of CI practice as organizational maturity increases, reducing the risk of ineffective or incomplete improvement outcomes. To examine whether CI maturity is associated with the use of project management methodologies (HRQ2a), an overall methodology-use index was calculated for each respondent. The Spearman correlation analysis (Tab. 2) revealed a significant moderately positive relationship, indicating that more mature organizations apply PMMs more extensively. Additional item-level analysis showed that the strongest correlations occurred for PMM 1-PMM 8, suggesting that more advanced and formalized approaches are characteristic of higher CI maturity. In contrast, PMI, SCRUM, and PRINCE2 showed only weak correlations ($.2 \leq \rho_s < .4$, $p < .05$), implying that their use is more sporadic and less dependent on CI maturity.

To assess whether the use of project management methodologies varied across types (HRQ2b), a Friedman test (Tab. 2) was conducted, confirming significant differences in their application frequency. Durbin-Conover post-hoc comparisons with Holm correction showed that tool-based approaches (PMM 6-PMM 8) differed significantly from fully formalized methodologies (PMM 1-PMM 5). No significant differences were observed between 'PMI' and 'PRINCE2' or between 'DMAIC' and 'PDCA', indicating that these pairs are applied with comparable frequency.

To examine whether the use of project management methodologies is associated with higher improvement effectiveness (HRQ2c), a right-tailed Spearman correlation (Tab. 2) was conducted between the overall methodological application index (PMM 1-PMM 8) and 18 improvement outcomes (IAE 1-IAE 18). With one exception, all correlations were positive and statistically significant ($\rho_s \geq .2$, $p < .05$), supporting the hypothesis that a more systematic project management approach is linked to more substantial improvement effects. Only 'improved product quality' (IAE4) showed no significant relationship, suggesting that respondents may attribute quality gains to dispersed, routine activities rather than structured project work. The strongest correlations ($\rho_s \geq .4$, $p < .05$) were observed for improvements in 'administrative procedures' (IAE18), 'cross-departmental cooperation' (IAE17), 'communication between management levels' (IAE12), 'employee absenteeism' (IAE16), 'customer satisfaction' (IAE7), 'work organization' (IAE10), 'order-fulfilment time' (IAE6), 'supplier cooperation' (IAE8), and 'workplace safety' (IAE9). These findings indicate that formalized methodologies enhance not only operational outcomes but also organisational and behavioural dimensions of CI performance.

Improvement project portfolio

Regarding the creation of IP portfolios (RQ3), 66% of organizations reported having one, typically established only when the number of projects becomes substantial. One-third do not use portfolios, and only 1% plan to introduce one. This indicates that portfolio management is still applied reactively rather than systematically, limiting strategic coordination and resource allocation. The relatively low level of formalization underscores the need for greater professionalization of improvement project management, particularly in more mature CI environments. Considering the above data, it has been tested whether organizations with a higher level of CI maturity are more likely to develop a portfolio of IP (HRQ3a). A right-tailed Spearman analysis (Tab. 2) show significant, moderate positive relationship between CI maturity and the use of IP portfolios. Thus, more mature organizations are substantially more likely to apply a systematic, portfolio-based approach to managing IPs.

A subsequent analysis examined whether more frequent use of project management methodologies is associated with more systematic development of IP portfolios (HRQ3b). A composite indicator of methodology use was correlated with portfolio practices, revealing a strong positive relationship (Tab. 2). This suggests that organizations that apply project management methodologies more consistently are also more likely to structure their CI initiatives into formal project portfolios, reflecting higher professionalization and more substantial alignment of improvement activities with strategic objectives. A more detailed analysis of individual project management methodologies (PMM 1-PMM 8) revealed the most exhibited moderate positive correlations with the creation of improvement project portfolios ($.4 < \rho_s < .6$, $p < .001$). Lower correlations were observed for tool-based practices: 'project charter' (PMM6), 'project schedule' (PMM7), and 'project leader' (PMM8) ($.29 < \rho_s < .4$, $p < 0.6$). This may suggest that these elements are treated as routine components of project work rather than standalone portfolio-building practices.

Factors Contributing to the Lack of Effectiveness in Improvement Projects

Analysis of Critical Failure Factors (CFFs) (RQ4) showed that respondents most frequently attributed project ineffectiveness to the lack of project leader's involvement (22.8%) and to changes in project scope and insufficient use of project management tools (21.5%). To examine whether the impact of failure factors differed across CFF types (HRQ4a), a Friedman test was conducted (Tab. 2). The test didn't show statistically significant differences in the perceived impact of the 13 CFFs. Although several unadjusted pairwise comparisons yielded p-values below 0.05, Durbin-Conover post-hoc tests with Holm correction indicated that none of the pairwise differences remained significant. These results suggest that respondents rated the influence of the various CFFs as relatively similar, with no factor standing out as significantly more impactful than others after controlling for multiple comparisons.

To verify respondents' assessment that the 'project leader's lack of engagement' has limited impact on CI project effectiveness (HRQ4b), the variable variables were grouped into three levels (low, medium, high disengagement). The effects of improvement projects (IAE 1-IAE 18) were compared across these groups using the Kruskal-Wallis test. Significant differences were found for four effects: 'process efficiency' (IAE 1, $\chi^2 = 11.29$, $p = .004$, $\varepsilon^2 = .164$), 'order completion time' (IAE6, $\chi^2 = 8.07$, $p = .018$, $\varepsilon^2 = .117$), 'safety and working conditions' (IAE9, $\chi^2 = 7.60$, $p = 0.22$, $\varepsilon^2 = .110$), and 'employee competences' (IAE13, $\chi^2 = 7.13$, $p = 0.28$, $\varepsilon^2 = .103$). In all cases, higher perceived disengagement of the project leader corresponded to lower reported project effectiveness. The effect sizes indicate a strong relationship for IAE 1 and moderate relationships for the remaining outcomes, suggesting that leader engagement plays a meaningful role in the perceived success of CI projects.

CONCLUSIONS

The study addressed four research questions concerning the implementation of IPs in manufacturing companies from Poland operating under CI. The results for RQ1 showed that the frequency of project implementation varies significantly across project types. Quality-oriented, efficiency-focused, and waste-elimination projects are executed most often, whereas 5S and Six Sigma projects are the least commonly used. These results are consistent with the approach of Antony and Gupta [23] and Thomas et al. [40], who emphasize that many process improvement methodologies exist, each developed to solve a specific type of operational problem. Organizations with higher CI maturity undertake improvement activities more intensively, particularly those requiring structured methods and cross-functional coordination. These findings reflect both practical constraints and strategic priorities of manufacturing firms, aligning with earlier studies that highlight the need to match tools and methods to organizational capabilities and problem types. Regarding RQ2, most companies (81%) reported using PMM in CI initiatives, though the extent of their application varies. Tool-based approaches (e.g., project schedules, charters, project leadership) are used more frequently than comprehensive methodologies such as PMI, PRINCE2, or SCRUM. Higher CI maturity was associated with a more systematic and extensive use of PMM, and the intensity of methodological application correlated positively with a wide range of improvement outcomes, both operational and organizational. This suggests that even simple, project-based practices can substantially enhance CI effectiveness when applied consistently. These results align with research by Tavana et al. [41], who demonstrated that the organization's lack of knowledge to implement a CI project is one of the most critical barriers to CI implementation. Evidence from Polish companies may point out the opposite relationship: the systematic use of PMM may correlate with higher CI project effectiveness. For RQ3, the study found that two-thirds of organizations develop portfolios of IPs, although often reactively (typically when project volume increases). CI maturity strongly correlated with portfolio development, as did the frequency of PMM use. This indicates that project methodologies may serve as a catalyst not only for more disciplined project execution but also for integrating CI initiatives into broader organizational planning and prioritization processes. This suggests that methodologies act as catalysts for the professionalization of CI management and support their integration with the organization's long-term strategy, consistent with research by Coronado and Antony [42]. The analysis conducted for RQ4 didn’t identify statistically apparent differences across all CFFs (Frideman analysis). Notably, while respondents did not rank ‘lack of project leader engagement’ among the most influential barriers, further analysis showed (Kruskal-Wallis) that it significantly differentiates project outcomes, particularly in areas requiring coordination, timeliness, and work-system improvements. This discrepancy suggests that organizations may underestimate the role of leadership involvement in the success of CI projects. Overall, the findings emphasize that operational barriers, especially ineffective project leadership, have a more substantial impact on CI outcomes than it may be assumed by managers. The results also highlight the need to professionalize CI project management practices, strengthen methodological competencies, and integrate project and portfolio approaches to support more effective, coherent, and strategically aligned improvement efforts. This result complements earlier findings on leadership-related failure factors in CI initiatives (e.g., [23, 39]) by demonstrating a discrepancy between managers’ perceptions of leadership disengagement and its actual impact on project outcomes.

The findings of this study provide several practical recommendations for organizations, who are managing improvement projects. First, the selection and scope of CI projects should be aligned with the organization's level of maturity. Less mature companies may benefit from focusing on basic improvement activities (e.g., 5S or daily improvements), while more advanced organizations should expand their capabilities to execute complex, strategically oriented projects. Firms with low project activity should invest in competence development and change-management practices to enable more systematic and effective CI project execution. Project approaches should be deliberately planned and supported by simple project tools - such as schedules or project charters - which may serve as a transitional step toward more formal methodologies. As the results indicate, consistent application of project management practices strengthens both operational outcomes and organizational aspects such as communication and cross-functional cooperation. Therefore, organizations should embed the use of PMM into their CI routines and utilize project portfolio planning to prioritize and coordinate improvement initiatives. Overall, the study highlights the importance of the professionalization of CI project management. Developing competencies in project-based improvement work, consistently applying project methodologies, and adopting portfolio practices can enhance the effectiveness, coherence, and strategic value of CI activities in manufacturing firms.

This study has several limitations. First, the sample consisted of 70 manufacturing companies operating in Poland, which restricts the generalizability of the findings. Broader, cross-country studies would allow for more comprehensive comparisons. Second, the research relied on self-reported survey data, which may introduce response bias or discrepancies between declared and actual practices. Future studies should incorporate objective performance indicators for projects to ensure accurate evaluation. Third, the cross-sectional design captures CI practices at a single point in time. Longitudinal research would enable a better understanding of how CI maturity and project management practices develop over time. Finally, while the study identifies statistically significant relationships, the correlational nature of the analysis prevents one from drawing causal conclusions. Further research, utilizing advanced modeling or mixed-methods designs, could enhance the explanatory power of these findings.

REFERENCES

[1] Carnerud, D., Jaca, C., Bäckström, I., (2018). Kaizen and continuous improvement – trends and patterns over 30 years. *TQM J*. 30, pp. 371-390.

[2] Pérez-Rave, J.I., Guerrero, R.F., Vallina, A.S., Echavarría, F.G., (2023). A measurement model of dynamic capabilities of the continuous improvement project and its role in the renewal of the company's products/services. *Oper. Manag. Res*. 16, pp. 126-140.

[3] Sanchez, L., Blanco, B., (2014). Three decades of continuous improvement. *Total Qual. Manag. Bus. Excell*. 25, pp. 986-1001.

[4] Singh, J., Singh, H., (2015). Continuous improvement philosophy – literature review and directions. *Benchmarking* 22, pp. 75-119.

[5] Suárez-Barraza, M.F., Ramis-Pujol, J., Kerbache, L., (2011). Thoughts on kaizen and its evolution: Three different perspectives and guiding principles. *Int. J. Lean Six Sigma* 2, pp. 288-308.

[6] Fryer, K., Ogden, S., Anthony, J., (2013). Bessant's continuous improvement model: Revisiting and revising. *Int. J. Public Sect. Manag*. 26, pp. 481-494.

[7] Kornfeld, B., Kara, S., (2013). Selection of Lean and Six Sigma projects in industry. Int. J. Lean Six Sigma 4, pp. 4-16.

[8] Kucińska-Landwójtowicz, A., Czabak-Górska, I.D., Lorenc, M., (2019). Project Management as an Element of Continuous Improvement in Production Companies. In: Soliman, K.S. (Ed.), Vision 2025: Education Excellence and Management of Innovations through Sustainable Eco-Nomic Competitive Advantage. Proceedings of the *34th International Business Information Man-Agement Association Conference* (IBIMA). International Business Information Management Association, pp. 7730-7742.

[9] Rudnik, K., Bocewicz, G., Kucińska-Landwójtowicz, A., Czabak-Górska, I.D., (2021). Ordered fuzzy WASPAS method for selection of improvement projects. Expert Syst. Appl. 169, 114471.

[10] Padhy, R., (2017). Six Sigma project selections: a critical review. Int. J. Lean Six Sigma 8.

[11] Kerzner, H., 2020. Innovation Project Management: Methods, Case Studies, and Tools for Managing Innovation Projects, John Wiley & Sons, Inc.

[12] Sailer, P., (2019). Project management methods as a way to ambidexterity. *Int. J. Manag. Proj. Bus*. 12, pp. 1061-1078.

[13] Pongboonchai-Empl, T., Antony, J., Garza-Reyes, J.A., Tortorella, G.L., Komkowski, T., Stemann, D., (2025). DMAIC 4.0 – innovating the Lean Six Sigma methodology with Industry 4.0 technologies. *Prod. Plan. Control* 1-22.

[14] Kucińska-Landwójtowicz, A., Czabak-Górska, I.D., Lorenc, M., (2021). Improvement projects - characteristics and classification. IBIMA Bus. Rev. 2020, pp. 1-13.

[15] Carvalho, M.M. de, Patah, L.A., Souza Bido, D. de, (2015). Project management and its effects on project success: Cross-country and cross-industry comparisons. *Int. J. Proj. Manag*. 33, pp. 1509-1522.

[16] Su, C.T., Chou, C.J., (2008). A systematic methodology for the creation of Six Sigma projects: A case study of semiconductor foundry. *Expert Syst. Appl*. 34, pp. 2693-2703.

[17] Barclay, R.C., Cudney, E.A., Shetty, S., Antony, J., (2022). Determining critical success factors for lean implementation. *Total Qual. Manag. Bus. Excell*. 33, pp. 818-832.

[18] Yüksel, H., (2012). Evaluation of the Success of Six Sigma Projects by Data Envelopment Analysis. *Int. J. Bus. Manag*. 7.

[19] Jin, H.W., Doolen, T.L., (2014). A comparison of Korean and US continuous improvement projects. *Int. J. Product. Perform. Manag*. 63, pp. 384-405.

[20] Achibat, F.E., Lebkiri, A., Aouane, E. mahjoub, Lougraimzi, H., Berrid, N., Maqboul, A., (2023). Analysis of

the Impact of Six Sigma and Lean Manufacturing on the Performance of Companies. *Manag. Syst. Prod. Eng*. 31, pp. 191-196.

[21] Fryer, K.J., Ogden, S.M., (2014). Modelling continuous improvement maturity in the public sector: Key stages and indicators. *Total Qual. Manag. Bus. Excell*. 25, pp. 1039-1053.

[22] Marin-Garcia, J.A., Val Manuela, P. de, Bonavía Martín, T., (2008). Longitudinal study of the results of continuous improvement in an industrial company. *Team Perform. Manag*. 14, pp. 56-69.

[23] Antony, J., Gupta, S., (2019. Top ten reasons for process improvement project failures. *Int. J. Lean Six Sigma* 10, pp. 367-374.

[24] Sanchez-Ruiz, L., Gomez-Lopez, R., Blanco, B., (2020). Barriers to effectively implementing continuous improvement in Spanish firms. *Total Qual. Manag. Bus. Excell*. 31, pp. 1409-1426.

[25] Sunder, M, V., Prashar, A., (2020). Empirical examination of critical failure factors of continuous improvement deployments: stage-wise results and a contingency theory perspective. *Int. J. Prod. Res*. 58, pp. 4894-4915.

[26] Bader, M., Antony, J., Jayaraman, R., Swarnakar, V., Goonetilleke, R.S., Maalouf, M., Garza-Reyes, J.A., Linderman, K., (2024). Why do process improvement projects fail in organizations? A review and future research agenda. *Int. J. Lean Six Sigma* 15, pp. 664-690.

[27] Albliwi, S.A., Antony, J., Arshed, N., Ghadge, A., (2017). Implementation of lean six sigma in Saudi Arabian organisations: Findings from a survey. *Int. J. Qual. Reliab. Manag*. 34, pp. 508-529.

[28] Fannon, S.R., Munive-Hernandez, J.E., Campean, F., (2022). Mastering continuous improvement (CI): the roles and competences of mid-level management and their impact on the organisation’s CI capability. *TQM J*. 34, pp. 102-124.

[29] McDermott, O., Antony, J., Sony, M., Daly, S., (2022). Barriers and Enablers for Continuous Improvement Methodologies within the Irish Pharmaceutical Industry. Processes 10, 73.

[30] Alvarado-Ramírez, K.M., Pumisacho-Álvaro, V.H., Miguel-Davila, J.Á., Suárez Barraza, M.F., (2018). Kaizen, a continuous improvement practice in organizations: A comparative study in companies from Mexico and Ecuador. *TQM J*. 30, pp. 255-268.

[31] Jurburg, D., Viles, E., Tanco, M., Mateo, R., (2017). What motivates employees to participate in continuous improvement activities? *Total Qual. Manag. Bus. Excell*. 28, pp. 1469-1488.

[32] Jaca, C., Viles, E., Mateo, R., Santos, J., (2012). Components of sustainable improvement systems: Theory and practice. *TQM J*. 24, pp. 142-154.

[33] Oprime, P.C., Sousa Mendes, G.H. de, Pimenta, M.L., (2011). Continuous improvement: Critical factors in Brazilian industrial companies. *Int. J. Product. Perform. Manag*. 61, pp. 69-92.

[34] Middel, R., Weegh, S. Op De, Gieskes, J., (2007). Continuous improvement in the Netherlands: A survey-based study into current practices. Int. J. Technol. Manag. 37, pp. 259-271.

[35] Terziovski, M., Power, D., (2007). Increasing ISO 9000 certification benefits: A continuous improvement approach. Int. J. Qual. Reliab. Manag. 24, pp: 141-163.

[36] Corso, M., Giacobbe, A., Martini, A., Pellegrini, L., (2007). Tools and abilities for continuous improvement: What are the drivers of performance? *Int. J. Technol. Manag*. 37, pp. 348-365.

[37] Omotayo, T.S., Kulatunga, U., Bjeirmi, B., (2018). Critical success factors for Kaizen implementation in the Nigerian construction industry. *Int. J. Product. Perform. Manag*. 67, pp. 1816-1836.

[38] Aleu, G.F., Aken, E.M. Van, (2016). Systematic literature review of critical success factors for continuous improvement projects. *Int. J. Lean Six Sigma*.

[39] McLean, R.S., Antony, J., Dahlgaard, J.J., (2017). Failure of Continuous Improvement initiatives in manufacturing environments: a systematic review of the evidence. *Total Qual. Manag. Bus. Excell*. 28, pp. 219-237.

[40] Thomas, A.J., Francis, M., Fisher, R., Byard, P., (2016). Implementing Lean Six Sigma to overcome the production challenges in an aerospace company. *Prod. Plan. Control* 27, pp. 591-603.

[41] Tavana, M., Shaabani, A., Valaei, N., (2021). An integrated fuzzy framework for analyzing barriers to the implementation of continuous improvement in manufacturing. *Int. J. Qual. Reliab. Manag*. 38, pp. 116-146.

[42] Coronado, R.B., Antony, F., (2002). Critical success factors for the successful implementation of Six Sigma projects in organisations. *TQM Mag*. 14, pp. 92-99.

Aneta Kucińska-Landwójtowicz
Department of Management
and Production Engineering
Faculty of Production Engineering and Logistics
Opole University of Technology
ul. gen. Kazimierza Sosnkowskiego 31
45-272 Opole, Poland
e-mail: a.kucinska-landwojtowicz@po.edu.p

Izabela Czabak-Górska (corresponding author)
Department of Management
and Production Engineering
Faculty of Production Engineering and Logistics
Opole University of Technology
ul. gen. Kazimierza Sosnkowskiego 31
45-272 Opole, Poland
e-mail: i.czabak-gorska@po.edu.pl