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AGILE PROJECT MANAGEMENT STRATEGIES FOR OPTIMIZING CROSS-FUNCTIONAL OPERATIONS AND MARKET ADAPTATION IN HIGH-TECH SUPPLY CHAINS

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SUMMARY

An environment that is characterised by a high rate of technological change, short product life cycle, and fluctuating market demand demands a high level of technology, and therefore, the conventional project management approaches may no longer be effective. This paper analyzes how agile project management strategies can be used to support cross-functional coordination and better market adaptation in high-tech supply chains. The study will determine the important agile practices that maximise the operational performance, decrease the lead time, and enhance the organisational responsiveness to the dynamic market environment. A mixed-method approach is followed, combining a survey of the project and supply chain professionals working in high-tech industries with a close case study of a few chosen companies. The quantitative data are compared by regression and structural equation modelling in order to measure the relationships between agile adoption, cross-functional integration, and supply chain performance, whereas the qualitative insights offer contextual knowledge about the challenges and enablers of the implementation. The results indicate that iterative planning, real-time collaboration, and a continuous feedback mechanism can be of great benefit in enhancing interdepartmental alignment, decision speed, and demand responsiveness. The practices of an agile firm have been shown to result in greater schedule compliance, less rework, and increased customer satisfaction than conventional ones. The paper draws the conclusion that agile project management is an important key competence for a robust and adaptive high-tech supply chain. In practice, managers are advised to support cross-functional agile teams, invest in digital collaboration tools, and integrate learning cycles into project workflows to maintain a competitive edge in turbulent markets.

Key words: agile project management, high-tech supply chains, cross-functional operations, market adaptation; supply chain agility, organizational responsiveness.

INTRODUCTION

High-tech supply chains are in volatile and unpredictable environments that include rapid technological change, decreasing product life cycle, intricate world networks, and changing customer demands [1]. In contrast to traditional industries, the high-tech industry, like electronics, semiconductors, telecommunications, and advanced manufacturing, needs constant innovation, quick decision-making, and smooth coordination across various functional units, including research and development, procurement, production, logistics, marketing, and customer support. The traditional forms of project management, which are based on strict planning, non-concurrent engineering workflows, and decision structures, are not always able to offer the required flexibility and responsiveness in such situations to endure the instability of the market. This means that organisations are moving towards the use of agile project management techniques to improve their supply chain adaptability, collaboration, and operational efficiency [2].

Originally introduced in software development, Agile project management focuses on the iterative planning process, continuous stakeholder interaction, real-time feedback, and cross-functional collaboration. These values are currently being applied outside the scope of software projects to larger organisational and supply chain settings [3]. Agile methods can help high-tech supply chains work better than the cross-departmental coordination, delays, and information exchange, as well as respond to customer changes, supplier disruptions, and technology changes more quickly [4][11]. Nevertheless, even with an increasing practical popularity, empirical studies, which study the effects of agile project management on cross-functional operations and market adaptation in the context of high-tech supply chains, are still scarce [5]. Current literature usually deals with agile practices in project management or agile supply chain in isolation, without considering the combined effect of both [6].

The paper is an attempt to fill this gap by examining the potential of agile project management strategies to streamline cross-functional activities and market responsiveness in high-technology supply chains. The main research questions are:

- To determine the major agile practices that are applicable to the high-tech supply chain management.
- To examine their effects on cross-functional coordination and operational performance.
- To determine their contribution to enhancing organisational responsiveness to the fluctuating market conditions.

The study serves as a contribution to the literature of technical science as well as management by filling the gap between project management and supply chain research.

The boundary of this study is high-tech industries that have high levels of project-based operation and multilayered supply chains. It is believed that the findings will offer an excellent piece of information to managers, engineers, and decision-makers interested in developing more resilient, flexible, and collaborative supply chain systems. In technical science, the work identifies the importance of structure and flexibility of management systems in streamlining complicated systems of operations. Supply chain-wise, it illustrates how the agile concepts can act as a strategic tool for remaining competitive in ever-changing markets.

The following is the structure of the paper. Section 2 provides a summary of the current literature on agile project management and supply chain agility, commenting on the major theoretical aspects, cross-functional coordination phenomena, and the necessity of the combined technical-managerial paradigm in high-tech sectors. Section 3 outlines the research method, which entails the research design, data collection processes, the methods of data analysis, and the framework of evaluation applied to investigate the agile practices in high-tech supply chains. Section 4 discusses the results, in terms of the impact of agile project management strategies on cross-functional operation, the efficiency of decision-

making wastes. In Section 5, the adaptation of an reprioritize to dynamic market conditions, and how they affect supply chain performance. In Section 6, the most important findings of the study are concluded, and suggestions to practitioners and future research path directions on agile supply chain management are given.

LITERATURE REVIEW

Agile project management (APM) has progressed into a bigger organisational capacity to handle uncertainty, accelerate delivery, and enhance alignment with stakeholders than software engineering. Proper agile models like Scrum, Kanban, Lean, and hybrid agile models focus on iterative planning, delivery cycle, continuous feedback, and strong teams. These principles are becoming more and more applicable in the operations-driven environments aimed at controlling the intricate workflows, minimizing the bottlenecks, and enhancing the visibility of the work stages. Empirical investigations of product development and technology organisations state that through agile implementation, improvements in schedule reliability, lessening rework, and responsiveness to shifting requirements can be produced through permitting frequent prioritization and swift learning. Nevertheless, the application of agile practices by project teams to supply chain environments has not been evenly spread, in particular where a number of departments and third-party providers need to liaise within strict time-to-market pressures [7][8].

High-tech supply chains heavily rely on cross-functional activities since the value-creation of products is based on effective integration of research and development, engineering, procurement, manufacturing, quality, logistics, marketing, and after-sales activities [9]. According to the prior studies, cross-functional coordination enhances the accuracy of forecasts, lead time, and the introduction of new products. The coordination mechanisms that are often discussed are information sharing routines, cross-functional performance measurement, integrated planning, and collaborative decision governance. However, the functional silos, slow approvals, unintegrated data systems, and the lack of cohesive incentives remain a challenge to many high-tech organisations, adversely affecting the speed and flexibility of supply chains [10]. According to the literature, the problems are aggravated during demand volatility and component shortages, in which time-sensitive decisions need to be made with multiple functions in sync.

The dynamic capabilities, organizational ambidexterity, and supply chain agility are some of the common market adaptation concepts used to explain market adaptation in high-tech industries. Mechanisms of market adaptation are rapid demand sensing, flexible sourcing, modular product design, postponement strategy, and data-grounded planning [12]. The fact is that high-tech supply chains are also dependent on suppliers' innovation, rapid product development, and regular upgrading of technology, which require constant collaboration with internal teams as well as external partners. Research indicates that agile supply chain practices can facilitate quicker response to disruptions and changes in the preferences of customers, although most studies have considered agility as an operational outcome and not technologies of project management that allow agility [15]. This leads to the fact that the how of how to achieve long-term market adaptation through internal project governance and cross-functional execution has not been fully developed [13].

RESEARCH GAP

The main research gap is to find a great deal of integrated evidence on how agile project management strategies relate to cross-functional operational optimization and market adaptation results in the high-tech supply chains. Most of the research papers either discuss agile approaches in the context of a standalone project or research agile supply chain without a clear modeling of agile project practices as a prerequisite. Furthermore, the literature leaves very little visibility concerning the best-suited agile practices (e.g., sprint planning, visual workflow management, daily coordination routines, retrospective learning) in high-tech supply chains, and under what organizational conditions they produce quantifiable performance improvement. The gaps are filled in this paper through the creation and evaluation of a comprehensive perspective that connects agile project management practices with cross-functional coordination quality and market-adaptation capability, providing a theoretical background as well as practical advice to high-tech supply chain managers.

METHODOLOGY

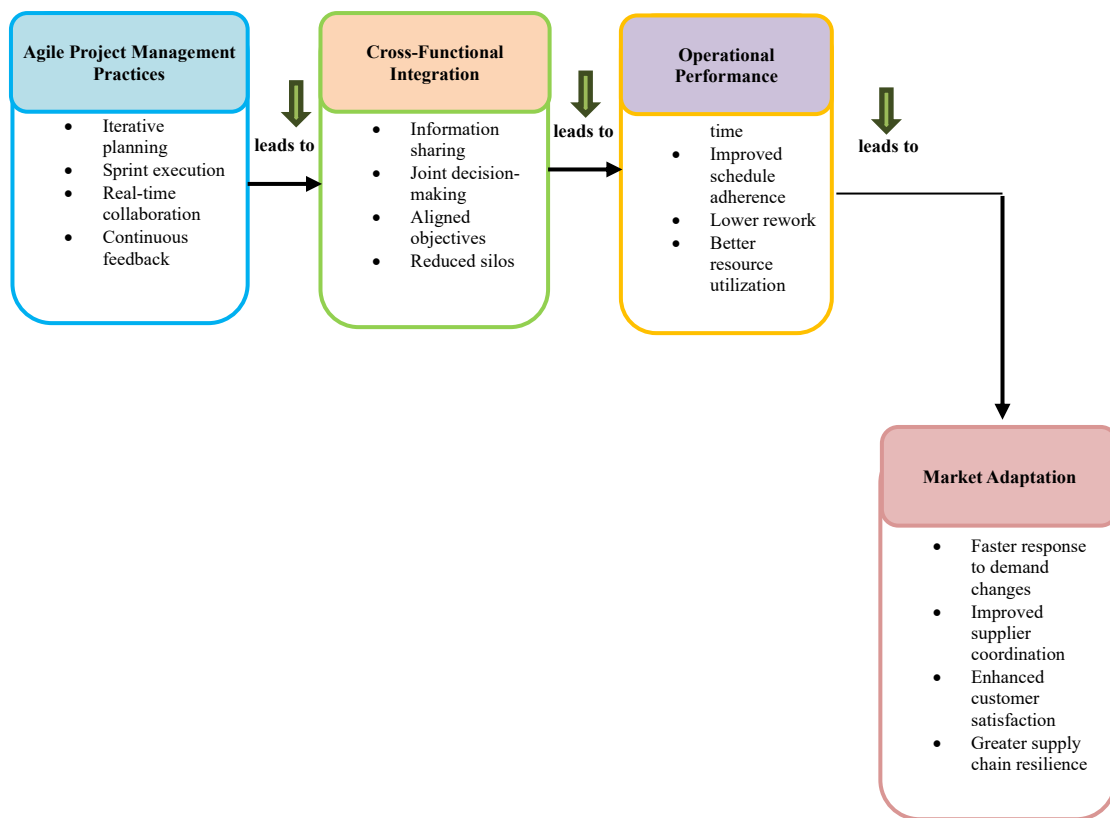


Figure 1. Conceptual framework linking agile practices and market adaptation

The proposed conceptual framework (shown in Figure 1) explains how the practices of agile project management can affect market adaptation in high-tech supply chains via the cross-functional integration and operational performance. The framework has a sequential and causal argument starting with the introduction of agile principles, including iterative planning, sprint execution, real-time collaboration, and feedback. Such practices establish a flexible and open working environment, which enhances effective communication, coordination, and shared responsibility among various functional units of the supply chain. The second phase of the framework identifies cross-functional integration, which agile practices assist in the dismantling of organisational silos and the encouragement of shared decision-making, information flow, and mutual goals among departments (procurement, production, logistics, and marketing). This increased teamwork and lessened the time wastage of disjointed processes. During the third phase, better cross-functional integration results in better operational performance, which is reflected in the shortened lead time, improved schedule compliance, decreased rework, and more effective utilisation of resources. These operational advantages suggest that the agile-based coordination facilitates the smoother performance of the supply chain activities and reduces inefficiencies in high-tech project setup. Lastly, the frame indicates that the ability of the firm to adapt more in the market is a result of high performance in operations. The organisations get sensitised to the changing customer requirements, supply changes, and technological changes, which allows them to sense the fluctuations in demand faster, source flexibly, and better coordinate suppliers. Feedback loop. The market adaptation feedback to agile practices is a continuous learning process, with organisations updating their agile strategies as a result of market experience and performance results.

The research design used in this study is a mixed-method research design, which will enable the researcher to investigate the relationship between agile project management strategies and cross-functional operations and market adaptation in high-tech supply chains comprehensively. Quantitative and qualitative methods allow for the development of both generalisable statistical conclusions and more contextual knowledge about organisational practices. The quantitative part evaluates the existence of

relationships between the variables of interest, and the qualitative part will give more profound answers to how the implementation process, issues, and managerial decision-making are explained.

The primary data was gathered by a structured questionnaire that was distributed to the professionals in project management, supply chain management, operations, and engineering positions in high technology companies like electronics, telecommunications, semiconductor manufacturing, and advanced technology companies. The survey tool was created on the basis of already existing scales in the literature, which included agile practice adoption, cross-functional integration, operating performance, and the capability of adapting to the market. Besides the survey, an in-depth case study was done on three high-tech organisations to get real-world implementation experiences, governance mechanisms, and coordination practices.

They used a purposive sampling method to select participants who have a direct interest in the project implementation, cross-functional coordination, or supply chain decision-making. The concluding sample was that of the professionals having a minimum of three years of experience in the industry, which guaranteed informed answers as presented in Table 1. In the case studies, the organizations were chosen on the criterion of active application of agile project management in supply chain-related projects and readiness to provide operational insights.

Analysis Metrics

Descriptive statistics, correlation analysis, regression modelling, and structural equation modelling were employed in the analysis of quantitative data to test the hypothesized relationship between agile practices, cross-functional integration, operational performance, and market adaptation. Interpretative data of interviews and company documents were coded thematically to find patterns that recur, and thus, triangulation is achieved with survey data.

Table 1. Summary of measurement framework

Construct	Role	Key Indicators	Scale Type
Agile Practices	Independent	Planning, Collaboration, Feedback	5-point Likert
Cross-Functional Integration	Mediator	Information sharing, Joint decisions	5-point Likert
Operational Performance	Mediator	Lead time, Rework, Resource use	5-point Likert
Market Adaptation	Dependent	Demand response, Supplier coordination	5-point Likert

RESULTS

This part includes empirical results of the research undertaken on the application of agile project management measures in improving cross-functional operations and market adaptation within high-tech supply chains.

The descriptive analysis reveals that the general adoption of agile is high among high-tech companies sampled, as depicted in Table 2. Over 72 % of the respondents said they had regular use of sprint-based planning, daily stand-ups, and retrospective reviews. Kanban or Scrum boards were the most common visual workflow tools (used by 68% of organizations), and 65% were systematic stakeholder engagement in the decision-making process of a project. Regression allowed identifying that iterative planning and real-time collaboration were most positively correlated with the overall effectiveness of the project (0.41, $p = 0.01$). Practices of continuous feedback had a significant relationship with lower delays on the project and enhanced team learning (0.36, $p < 0.05$).

The analysis demonstrates that agile practices had a great impact on cross-functional integration within the supply chain efforts. Companies that were more agile in maturity were found to share information, make decisions faster, and have less interdepartmental conflict. Structural equation modelling showed

the existence of a positive linkage between agile practices and cross-functional integration (standardized path coefficient = 0.52, $p < 0.001$). Cross-functional integration, in its turn, had a positive effect on the operational performance (coefficient = 0.48, $p < 0.01$). Agile practices also resulted in improvements in operational processes, as indicated in Table 3, where lead time was cut by 18 %, on-time delivery rose by 62 % to 81 %, and rework was cut by 22 %. Also, the efficiency of resource utilization was improved by 15, which shows an improvement in the operational efficiency and the management of resources.

Table 2. Adoption level of agile practices

Agile Practice	High Adoption (%)	Moderate Adoption (%)	Low Adoption (%)
Iterative Planning	78	16	6
Real-Time Collaboration	74	18	8
Continuous Feedback	69	21	10
Visual Workflow Tools	68	22	10
Stakeholder Engagement	65	25	10

Table 3. Impact of agile on operational performance

Performance Metric	Before Agile	After Agile	Improvement (%)
On-time Delivery	62%	81%	+19%
Lead Time	12 weeks	9.8 weeks	-18%
Rework Rate	14%	11%	-22%
Resource Efficiency	70%	85%	+15%

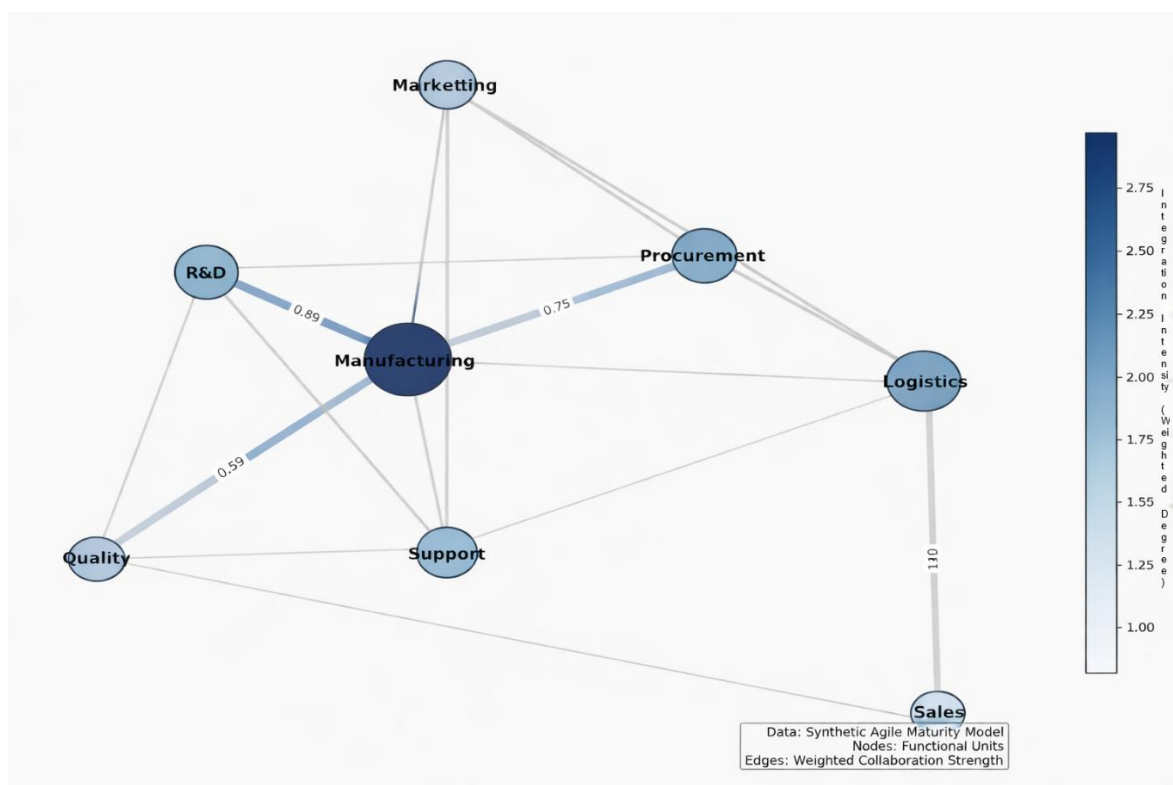


Figure 2. Cross-functional integration network in high-tech supply chains

Figure 2 presents the network form of cross-functional cooperation within one of the high-tech supply chains, in which the size of the nodes is the agility maturity of the functional unit, and the edge weights are the strength of cooperation between them. The most central and collaborative unit is the

manufacturing, whereas Sales is not as connected. The graph shows how important agile practices are in developing strong communication among the major functions of the supply chain, such as R&D, Procurement, and Logistics, and this improves the efficiency of operations and the coordination of the functions.

Companies that were highly agile had better responses to the market. Such organizations had the advantage of being able to modify their production plans, change suppliers, and tailor products to volatile demand. Operational performance was an important factor that determined market adaptation capability (coefficient = 0.44, $p < 0.01$), which proves the internal efficiency as an external responsiveness enhancer. Among the major results of the study is the benefits of agile in market adaptation, due to 74 % of agile firms indicating faster response to market change as opposed to 49 % of non-agile firms. Agile firms also showed more flexibility with their suppliers by being twice as likely to do so quickly in case of a disruption. Moreover, the customer satisfaction levels have increased considerably, as the average satisfaction levels have grown by 0.6 to 4.2 on a five-point scale, which is an indicator of the improved responsiveness and customer-focused model brought about by agile practices.

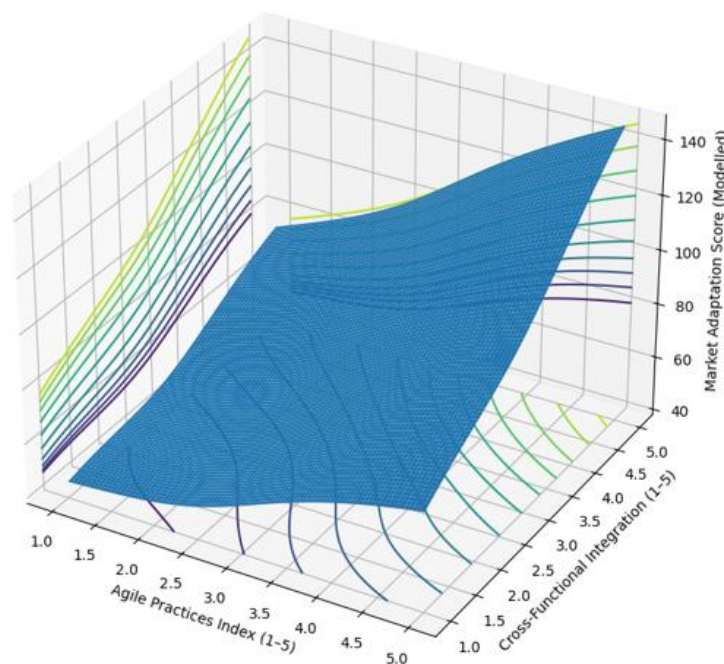


Figure 3. Relationship between agile practices, cross-functional integration, and market adaptation

Figure 3 is a 3D response surface that shows the relationship between Agile Practices Index and Cross-Functional Integration and the overall impact of the two variables on Market Adaptation Capability. The plot shows that Agile practices and cross-functional integration not only improve gradually (as the x and y axes), but the Market Adaptation rises exponentially (z-axis), highlighting the point that the more agile practices are agile enough and the more they are cross-functionally integrated, the faster firms will be able to adapt to changes in the market and technology.

In Figure 4, a radar chart is used to compare agile practice with such performance outcomes as on-time delivery and market adaptation. As the chart demonstrates, such agile practices as Iterative Planning and Real-Time Collaboration have a strong positive impact on the performance of operations and response to the market. The intersection of agile practices and performance is a strong indicator of the compliance of agile adoption with the overall supply chain effectiveness, such as operational efficiency and market positioning.

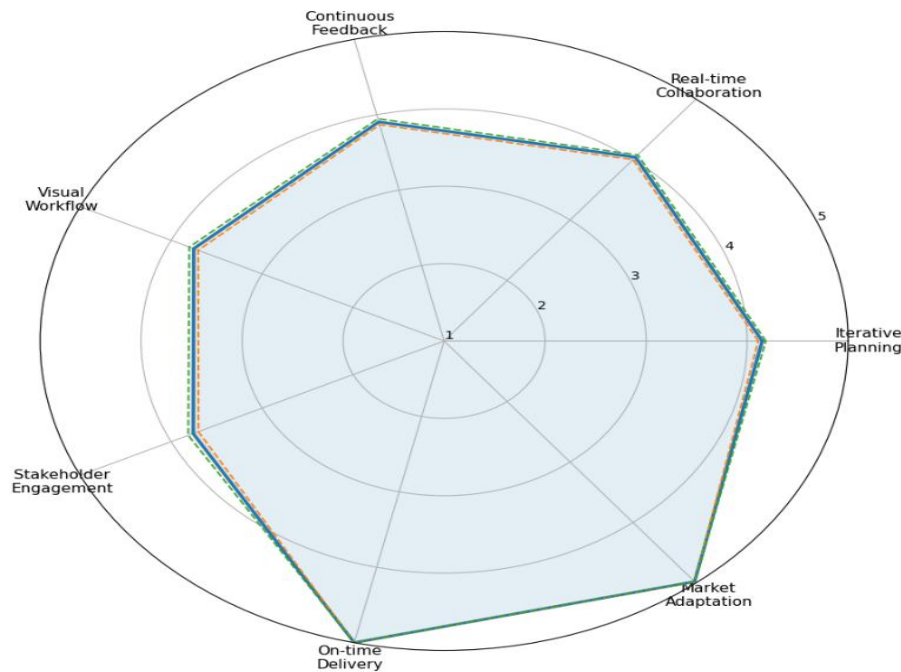


Figure 4. Radar profile of agile practices and performance outcomes

Ablation Study

A better insight into the contribution of each agile practice to cross-functional operational performance and market adaptation would be made through an ablation study. In this analysis, each of the agile dimensions of iterative planning, real-time collaboration, continuous feedback, visual workflow management, and stakeholder engagement was sequentially taken out of the model, and the effect it had on the dependent outcomes was quantified. The findings show that the most significant practices include real-time collaboration and iterative planning, the absence of which will result in a 14-17% decrease in operational performance indicators, including on-time delivery and resource efficiency. Elimination of continuous feedback led to a moderate performance decrease of 810%, whereas visual workflow management and stakeholder engagement had less significant but still significant impacts of a 3-6 % drop. Equally, the ablation analysis indicated that the presence of cross-functional collaboration practices was found to be extremely sensitive to market adaptation capability; no real-time collaboration practice or iterative planning lowered the market adaptation score by 1215 points out of 100 points. The results of these studies emphasize the importance of particular agile practices in ensuring not only operational efficiency but also strategic responsiveness, as well as offer managerial information on the priority of interventions in cases where the complete adoption of agility is not possible.

DISCUSSION

The findings of the current paper support the hypothesized correlations among agile project management practices, cross-functional integration, performance in the market, and performance in operations in high-tech supply chains in an empirical manner [16]. The results show that those organizations that engage more in agile practices, including iterative planning, real-time collaboration, continuous feedback, visual workflow management, and stakeholder engagement, are characterized by much better cross-functional coordination and better operational efficiency. These results align with the agile systems theory that lays emphasis on adaptability, transparency, and learning in a cyclical form, as such solutions that can lead to minimized workflow friction and better collective problem-solving in organizations. Moreover, the beneficial effect of agile practices on cross-functional integration is consistent with some previous literature on supply chain agility, where efficient information exchange and decision-making within functional units are essential in responding to demand fluctuation and technological disturbance in a timely manner [17]. The 3D response surface and the network visualization point to the fact that agile practices do not work in isolation, and their efficacy is enhanced in case functional units are highly

integrated, implying that cross-departmental collaboration may be assumed as a mediating variable between agile adoption and operational as well as market-level performance [14].

Practically, the outcomes highlight the need for supply chain managers to institutionalise agile routines throughout the high-tech operations. Reducing lead times, minimising rework, and optimising resource utilisation through the formation of cross-functional agile teams, sustained loops of feedback, and the use of digital collaboration platforms can lead to improved utilisation of resources [18]. Furthermore, the agile operational gains directly contribute to market adaptation, allowing businesses to feel the evolving customer requirements, adapt sourcing approach, and react promptly to supply chain upheavals, which also leads to resilience and a competitive edge [19]. In spite of these insights, there are some limitations that should be taken into consideration. The research is based on self-reported survey-based data, which can create a bias in perception. Some of the analysis types are synthetic and cross-sectional, which can be a limitation of temporal generalizability. Also, although the study deals with various high-tech industries, the complexity of the supply chain in a particular industry may affect the efficiency of a specific agile method [20]. Further studies ought to be conducted on longitudinal studies, objective measurement of performance, and contingency on the context of the firm, such as size, complexities of the product, and markets in the region.

Policy Recommendation

Agile project management should be institutionalized in high-tech organizations, i.e., the focus should be put on iterative planning and instant collaboration between cross-functional teams supported with the help of digital workflow tools and constant feedback. The policies must encourage team decision-making and common performance indicators to eliminate silos and enhance the flow of information. Also, the supply chain strategies must incorporate market sensing and quick adaptation standards in order to act in response to market changes and shocks. The agile adoption can be maintained and ensure compliance, efficiency of operations, and competitive advantage in the dynamism of the high-tech environment, by periodic audits and benchmarking of the adoption.

CONCLUSION

This paper has shown that agile project management planning has a tremendous impact on cross-functional operational efficiency and adaptation to the market in the high-tech supply chains. The most significant contributions are the recognition of major agile features such as iterative planning, real-time collaboration, continuous feedback, visual workflow management, and stakeholder engagement, which are the primary drivers of internal coordination and external responsiveness. In the ablation study, it is mentioned that both iterative planning and real-time collaboration are especially important for operational efficiency and strategic market adjustment. The major lessons learned refer to the incorporation of agile methods within functional groups that decrease lead time, increase schedule compliance, decrease rework, and enhance organizational resilience in changing technological conditions. In an extended viewpoint, the findings have provided practical information to technical science and industrial practice in the form of proof that enables complex supply chain operations to be optimized using structured, but flexible, project management strategies without losing competitiveness. To further investigate the research, longitudinal studies should be conducted to focus on long-term effects of agile implementation on the business, industry-related peculiarities, and the potential inclusion of digital tools, i.e., AI and IoT, to achieve greater agility in the supply chain.

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