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The Impact of Agile Operation Management on Products Development: The Mediating Role of Quality Function Deployment

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Abstract: Objective: Agile operation Management has become more popular in the present, where customers are expecting quicker and more integrated solutions. This research aims to look into how technological aspects may be used in the manufacturing sector of Jordan. And how the impact of quality function deployment (QFD) mediated agile operation management (AOM) in product development. **Methodology and procedures**: This study employed a descriptive and analytical approach. The Data were collected through a questionnaire distributed to 26 companies located in Amman. The collected data were analyzed using SPSS and AMOS-22 software. **Findings:** It is found that the efficiency and efficacy of product development are increased when the two modules of agile operation management i.e. intelligent dashboard and manufacturing process miners is combined with the quality function deployment. **Recommendations**: This study recommended that industrial companies develop a better understanding of customer needs, in addition to focusing on scheduling technical processes to ensure timely product delivery.

Keywords: Agile operation management, quality function deployment, product development.

أثر إدارة العمليات الرشيقة على تطوير المنتجات: الدور الوسيط لنشر وظيفة الجودة

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الملخص: الهدف: أصبحت إدارة العمليات الرشيقة أكثر شيوعًا في الوقت الحاضر، حيث يتوقع العملاء حلولًا أسرع وأكثر تكاملًا. يهدف هذا البحث إلى دراسة كيفية استخدام الجوانب التكنولوجية في قطاع التصنيع في الأردن، وكيف يؤثر نشر وظيفة الجودة (QFD) كوسيط في العلاقة بين إدارة العمليات الرشيقة (AOM) وتطوير المنتج. **المنهجية والإجراءات**: استخدمَت هذه الدراسة المنهج الوصفي والتحليلي، حيث تم جمع بيانات هذه الدراسة من خلال استبيان تم توزيعه على 26 شركة تقع في عمّان. وقد تم تحليل البيانات المجمعة باستخدام برنامجي SPSS و.AMOS-22 **النتائج**: أظهرت نتائج التحليل الاحصائي أن كفاءة وفعالية تطوير المنتجات تزداد عند دمج وحدتين من إدارة العمليات الرشيقة، وهما لوحة التحكم الذكية (Intelligent Dashboard) ومنقبو العمليات التصنيعية(Manufacturing Process Miners) ، مع نشر وظيفة الجودة. **التوصيات**: اوصت هذه الدراسة الشركات الصناعية بفهم أفضل لاحتياجات العملاء، بالإضافة الى الاهتمام بجدولة العمليات الفنية بحيث يتم تسليم المنتجات في الوقت المحدد.

الكلمات المفتاحية: إدارة العمليات الرشيقة، نشر وظيفة الجودة، تطوير المنتجات.

Introduction

In today's world firms are facing several problems in creating new goods that meet customer needs, with operation management emerging as one of the most persistent. In the business and professional sectors, projects and operation management are the most common method of work organization (Gemunden et al., 2018).

As per the findings of 9th survey of International Project Management (Project Management Institute, 2017), 71% of firms globally are utilizing agile approaches at some point in their project and operation management cycle. Additionally, using the approaches of agile manufacturing is necessary to provide more responsive and quick learning (Conforto et al., 2016).

Organizations must change to become more agile in order to keep up with the rapid advancement of the industry (Kane et al., 2016). Agile organizations are able to manage operations with the help of empowered, multidisciplinary project teams. But according to Conforto et al. (2016), the majority of non-software businesses were not built with this kind of management in mind.

The literature has recognized the value of flexible and agile operation management. Agile has been more and more popular in software development companies since the early 2000s. Agile has rapidly been adapted for contexts other than software because of its inventive nature and the improved outcomes it produces. Every year, its applicability grows.

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The industrial sector has also recently shown interest in increasing its level of agility, not just in the production process but in all aspects of its operations. And based on that, we created our problem statement, which states that *enterprises are under continual pressure to improve the efficiency and agility of their product development processes. In reaction to this circumstance, scholars and experts started to reconsider the strategies, asserting that the aforementioned were not really consistent with the latter.* (Serrador & Pinto, 2015; Nahar, & Manajrah, 2023).

Notwithstanding recent developments in the field, the question of whether these innovative approaches to product creation may be used in more established sectors, including the manufacturing industry, has emerged.

Furthermore, Marmer et al., (2011) stated that the rate at which technology and the Internet are developing has resulted in a proliferation of software across many industries, in addition to an abundance of options for system development methodologies. It raises an intriguing point about the capability of companies operating in the manufacturing industry, which is now having problems with this.

There have been recorded attempts to apply quality assurance techniques inside IT entrepreneurs utilizing Agile processes, and there have been discussions on applying QMSs to product development in Jordan's manufacturing sector to assist companies produce high-quality goods that live up to customer expectations. In this context, quality is defined as the capacity to evaluate, predict, and satisfy customer needs, whether explicit or implicit.

In order to assist businesses, solve their issues in a market that is highly competitive, enterprises need to be able to comprehend and fulfill the rapidly evolving needs of the customer, precisely capture the information about competition in the market information, save labor costs, minimize the duration required to develop new products, and make appropriate judgments about development of new product. (Yousefie et al., 2011). Attiany (2014) stated that quality together with innovation and efficiency are keys to achieve competitive advantage in manufacturing sector. Quality Function Development (QFD) is one of the more conventional ways to product development that have been used (Huang et al., 2022). It has less technological restrictions, concentrates more on how CRs and the manufacturing process work together, highlights the impact of the competitive environment on business choices, and can effectively communicate across departments. It can also gather more specific information from various sources about requirements information or product design faults (Chen et al., 2012; Al-khatib et al., 2025). QFD is therefore applied in our study.

However, it has been noted that combining agile operation management with a QMS improves the quality of product development. If so, we should think about putting into practice quality management techniques—more especially, agile operation management techniques—that could assist Jordanian manufacturing companies in achieving and guaranteeing the quality of their products in their development process.

The QFD (quality management tool) which has been modified to meet the needs of the Jordanian manufacturing sector, serves as the foundation for the agile operation management framework that we have presented in this paper. This framework is based on product development processes. And give rise to our research question i.e.

Q1: How quality function deployment mediates the influence oof agile operation management in product development?

And on the basis of above-mentioned question the main objectives of our work are:

- *To study the role of* QFD *(quality function deployment) as mediator in shaping the impact of agile operation management in product development*.

Some of the studies examined the use of agile operation management (AOM) in various sectors and industries, including software development and the automotive industry (Serrador & Pinto, 2015). Nevertheless, only a small number of these analyses were particularly concerned with Jordan's manufacturing sector. Additionally, these studies only looked at the impact of agile manufacturing on product development; they were conducted in various nations and may contain market peculiarities. For this reason, our paper's primary emphasis is on QFD mediating role in the effects of AOM on Jordan's manufacturing sector's product development.

Our paper has the following structure, section 1 includes the introduction of the paper together with the purpose of our study. In section 2 we have presenter the review of previous studies on agile operation management, product development and QFD. Section 3 explains the methodology adopted whereas finding and discussion are presented in part 4. The last part concludes the paper.

Review of Previous Studies

Agile and maneuverable resource planning techniques are essential in today's industry to foster learning and creativity through the formation of trustworthy teams, collaborative efforts, and opportunities for personal growth (Abrahamsson, 2017). Leybourn (2013) describes an agile approach as one that creates teams that operate autonomously, proactively, and collaboratively in order to reduce hierarchy within the structure and communication costs. It is the method for developing new items that is most relevant. The Agile Software Development Manifesto serves as the foundation for most agile techniques, which promote the idea that an evolving iterative process is more effective than original plans (Dyba & Dingsoyr, 2008 Al-Muntasir M. (2022).

The primary goal of the AOM system is to promptly identify problems through shop-floor data monitoring and provide a solution, even if it isn't the optimal one, given the available resources in the field.

As a result, the system uses the following process to assist managers and employees in understanding issues collectively. Together, the managers and employees keep an eye on the shop floor, and when an unexpected circumstance arises there, the managers use shop-floor data to comprehend the existing procedure. Before implementing an alternative in the field, managers and employees describe it, check each one, and decide which is the best option (Jo et al., 2014).

The industrial environment has undergone enormous change as a result of the substantial changes in consumer needs, technology, and market demands (Dohale et al., 2022; Al-khatib,2024). According to Kumar et al. (2022), using agile manufacturing techniques under challenging circumstances strengthens competitiveness, which improves market, financial, and operational performance. According to Strategic Direction study (2019), organizational agility facilitates more effective responses to unanticipated changes in the market. The relationship between agile practices, sustainable supply chain practices, sustainable practices, and operational performance was

investigated by Geyi et al. (2020). Their study's findings demonstrated that agile capabilities needed to be present and used in order to optimize the results of implementing sustainability practices.

The AOM system requires four component technologies in order to support the previously specified procedure i.e. data visualization, information mining, finding alternatives and verification of alternative and to implement these techniques there are four modules i.e. intelligent dashboard, manufacturing process miners, improvable alternative approach and factory process simulator mentioned by Jo et al., (2014). In our study we have studied the two modules intelligent dashboard and manufacturing process miners as the proxy for agile operating management.

The Intelligence Dashboard (ID) is a versatile visualization designed to meet the data acquisition and data visualization requirements. The dashboard studio, dashboard server, and dashboard client make up this system. Jo et al., (2014)

The dashboard studio edits the procedure that makes information with data from database, and visualize the information as visual types such as a table, bar chart or line graph. It delivers the edited procedure to the dashboard server by a defined dashboard file format of the R-script for the open statistics tool R and the visual type (Venables et al., 2003; Taqa, 2025)

The MPM consists of Process miners and the Intelligent Manufacturing Pre-processor (IMP). Process Miners is an open-source tool that conducts process mining based on event logs, and the IMP is a pre-processing module that finds connection information to make Process Miners mine whole processes (Process Mining Group, 2013, Oreqat 2021)

A method of converting customer needs into the appropriate specific requirements at every stage of the creation and development of a product including marketing tactics, making plans, product engineering and design, evaluation of prototypes, and creation of production processes, manufacturing, sales) is known as quality function deployment (QFD). In 1986, the Japan Quality Control Association's quality research division conducted the most extensive investigation on QFD use in Japan. According to the 30% of respondents, QFD was frequently used on a variety of items inside their companies. The matrix that is used the most commonly is the House of Quality. (Akao, 1990).

Owing to the COVID-19-caused global economic slump, the unstable purchasing environment for consumers and the depressing business climate for manufacturers have drastically altered how consumers buy and assess items (Campbell et al., 2020). As a result, an increasing number of customers are choosing to shop online, which gives them access to a greater variety of similar products and options while also exposing businesses to more intense competition (Nour, et. Al, 2022) . In order to assist businesses, turn around their problems in a competitive market, enterprises need to be able to comprehend and fulfill the fast-changing customer requirements, precisely capture the information of market competition (CIs), save labor costs, reduce the amount of time needed to produce new products (NPDs), and make appropriate judgments about NPD. In addition to having less technological restrictions, QFD highlights the impact of the fierce competition on business choices and places greater emphasis on the synchronization between requirements of customers and the process of production (Yazdani et al., 2017). It can also efficiently communicate across departments and gather more specific information from various sources about requirements information or product design faults (Chen et al., 2012). Applying the quality Tool for Function Deployment provide senior management with a challenge and chance to shift from the conventional focus on outcomes to an emphasis on methods for achieving goals by minimizing the time and effort required to deliver and redesign a product that truly satisfies customer expectations (Al-Mamori & Al-Mosawi, 2009).

In several scientific fields, quality function deployment (QFD) has been employed as a methodology. Other approaches, such resilient design and experimental design, may be used to comparable difficulties in other industries, particularly the manufacturing sector. QFD is a system designed to translate anticipated and incorporate customer requirements into specs that work for the business at all manufacturing levels (Nour, & Momani 2021). This covers the creation and design of the product, the manufacturing procedure, as well as the product's delivery and client usage. (Bahia et al., 2023). In contrast to monitoring customer expectations, managers should instead concentrate more on identifying the service aspects that matter most to consumers. QFD is seen to be a useful tool for the service sector, especially the hotel sector. The most crucial stage in QFD input information is gathering customer requirements, which is crucial for consumer-driven product design. In contrast, questionnaires are used in traditional QFD for the collecting and analyzation of CRs data, which can be time-consuming and subjective at times (Wu et al., 2018).

A grey QFD model was presented by Liu and Cheng (2016). It computes the impact of the market on significant engineering properties, integrates gray digits at intervals into the QFD setup, takes a competitive evaluation into account during calculation, and adds associated elements in the engineering properties' final weights. Ocampo (2020), on the other hand, view QFD as a tool for converting fundamental customer needs into technical specifications suitable for every phase of the product development and manufacturing process.

According to Al-Maamouri and Al-Mousawi (2009), QFD is a systematic strategy to ongoing process improvement and development of product, that translates customer needs—or the voice of the customer—into technical requirements and quality standards for product design and spreads this throughout all phases of the manufacturing process with the help of various associated functions in order to deliver value that guarantees and then maintains customer satisfaction. From the aforementioned definitions, it is clear that QFD is a quality control philosophy that emphasizes hearing what customers have to say and turning their needs into suitable technical specifications in order to attain and sustain widespread satisfaction. According to Attiany et al., (2021), there study showed how concerned Jordanian Islamic banks are about upholding high quality for financial services in an effort to meet customer needs.

To help IT startups achieve customer satisfaction and support them during their development process, all while ensuring the quality of their deliveries, Dovleac (2020) established a methodology. The Quality Function Deployment approach serves as the model's foundation, but it also takes startup enterprises' unique needs into consideration. IT startups have used and tested the suggested model. The three firms under analysis—one focused on products, one on a combination of products and services, and the third on services—were used to evaluate the model through their implementation. With the use of the model, the startups were able to more effectively comprehend the needs of their clients and schedule the execution of technical features to ensure timely product delivery.

Hypothesis Development

Based on the literature listed above, we have developed the following hypothesis to be tested.

H1: Intelligent dashboard of agile operation management has positive and significant impact on quality function deployment.

H2: Manufacturing process miners of agile operation management has positive and significant impact on quality function deployment.

H3: Quality function deployment positively influences product development

H4: Quality function deployment mediates the influence of agile operation management in the product development.

Methodology

For the purpose of evaluating the empirical study of agile operation management's influence on product development as mediated by the quality deployment function, we make an effort to gather data from Jordan's manufacturing industry. The variables into consideration were evaluated using a survey questionnaire in a causal and descriptive research design. Jordan's Amman city was chosen for a suitable sample approach because of the scale of the business. The primary source of data was an online survey. Path analysis, regression analysis, and correlation analysis are performed using SPSS and AMOS software.

We have focused on the influence of Agile operation management on product development. We have included two main techniques of agile operation management i.e. data visualization and information mining and for that two main modules of agile operation management i.e. intelligent dashboard and manufacturing process miners.

Data Collection

All private sector manufacturing enterprises in Jordan were considered the research population. Public or government-controlled enterprises were excluded from this analysis. Additionally, businesses in industries apart from manufacturing were not included in this analysis. Due to their size and range of operation, enterprises in Jordan's Amman city, including Al-Ibtikar for Import & Export and Al-Jazeera Trading FZCo, were selected for a proper sample approach in order to obtain a fair level of representation. As a result, to research this concept, it involved 26 companies in the industry for empirical analysis. These companies include those in the electronic and electrical, mechanical, textile, food, industrial, medical, and chemical sectors.

The size and kind of products manufactured by the enterprises included in this study varied. Additionally, companies had to have at least one production site and provide all of their contact information in order to be included in the population under study. And then, to the correspondents, emails were sent. (General Managers, Production Managers, Plant Managers, Supervisors and Distribution manager) 240 responses were received with valid data for further analysis.

A thirty-five-item questionnaire was created with the purpose of gathering data on twelve items measuring product development (manufacturing process and equipment, manufacturing scheduling, supplier relationship), ten items measuring agile operation management including five each for data visualization and information mining. The thirteen items measuring quality function deployment were scored using a Likert scale with five points: one for strongly disagreeing and five for strongly agreeing.

Findings and Discussion:

Analysis of the demographics

The summary of the survey participants' personal characteristic results is displayed in Table 1. The majority of participants were men and at least 35 years old, as the results show. The majority of respondents to our survey are in managerial positions.

Table (1): Demographic Analysis.

	Description	F	%
Gender	Male	182	75.8
	Female	58	24.2
Age	18 to 25	12	5
	26 to 35	56	23.3
	36 to 45	132	55
	45 and above	40	16.7
Designation	General Manger	112	46.7
	Plant Manger	54	22.5
	Production Manager	25	10.4
	Supervisors	26	10.8
	Distribution Manager	23	9.6

Reliability, descriptive and correlation analysis

When Cronbach's Alpha has been used to evaluate the data reliability, the findings showed a high reliability value for more testing. The quality deployment function (QFD) of 0.88, the intelligent dashboard (ID) of 0.91, manufacturing process miners (MPM) of 0.95 and the product development (PD) of 0.84 indicated that the data is sufficiently reliable to be used. At 3.9, the mean, and 88%, the standard deviation for ID and 3.7, the mean and 84%, the standard deviation for MPM and 3.6, the mean and 69%, the standard deviation for QFD, descriptive analysis demonstrates a fair degree of agreement with the questionnaire questions to a fair degree of agreement. The majority firmly agrees when it comes to product development, according to 4.1, the mean and 73%, the standard deviation The correlation analysis demonstrated a significant association between the variables with the value of p less than 0.05.

Table (2): Summary of Reliability, Descriptive and correlation.

	Cronbach's alpha	Mean	Stnd. dev	ID	MPM	QFD	PD
ID	0.93	3.9	0.88	1.00			
MPM	0.95	3.7	0.84	0.796**	1.00		
QFD	0.88	3.6	0.69	0.822**	0.742**	1.00	
PD	0.84	4.1	0.73	0.791**	0.811**	0.804**	1.00

* $p < 0.001$

** $p < 0.05$

Path analysis

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As previously mentioned, basic analysis was conducted using SPSS, the model was evaluated using AMOS-22, and path analysis (SEM) was employed. One method for multivariate analysis that is used to assess the link between variables is path analysis. It is also regarded as a component of structural equation modeling and regression analysis.

The chi-square value in the present model is 10.722, the DF is 5, and the probability is 0.096. The Chi-square value is an important component of the model; a small number suggests that the theory and model being suggested are accurate. A 3:1 fit ratio between the chi-square and the degree of freedom is considered appropriate. The present model has a minimum Chi-square value of 4.601, a probability of 0.212, and three degrees of freedom.

Model fit summary

Degree of Freedom 3 values and p = 0.212 show that the existing model's goodness of fit was validated. In contrast to other multivariate methodologies, if the value of p is not significant in the current model, which uses structural equation modeling with multivariate data analysis, it is regarded as a good match. The value of chi-sqr/df should be within the permissible range of 1 to 3. The findings indicate that the goodness of fit is indicated by the chi-sqr/df value of 1.640, which is within an acceptable range. Additionally, the chi-square value is 4.601.

Table (3): Model fit summary.

Model	NPAR	Chi-sqr	Df	Significance	Chi-sqr/df
Default	11	4.601	3	0.212	1.640
Saturated	12	0.0000	0		
Independence	8	323.167	6	0.0000	54.188

Baseline comparisons

We used the Normed Fit Index (NFI), RFI, Tucker-Lewis Fit Index (TLI), Incremental Fit Index (IFI), and Comparative Fit Index (CFI) to assess the goodness of fit. Table 5 shows that the RFI value is 0.988, the suggested value is 0.9, and the NFI is 0.976, which is higher than the 0.9 (recommended value by Bentler & Bonett, 1980). It has an IFI of 0.984. Bentler and Bonett (1980) state that the IFI index's cutoff value is 0.95. According Tucker & Lewis's (1973) criterion, the TLI value must be close to 1 for a better-fitted model, and the findings indicate that it is 0.994. Given that all of the aforementioned results fall within a reasonable range, the suggested model appears to be a good fit.

Table (4): Goodness of fit.

Model	NFIΔ11	RFIρ1	IFIΔ12	TLIρ2	CFI
Default	0.976	0.988	0.984	0.994	0.992
Saturated	1.000		1.000		1.000
Independence	0.000	0.000	0.000	0.000	0.000

Parsimony adjusted measures

The Proximity Adjusted Measures (PCFI and PNFI) have values of 0.499 and 0.496, respectively, and the suggested value of these measure is 0.5, so our findings in table 5 are very close to recommended values. Another popular measure of absolute fit is the Root Mean Square Error of Approximation (RMSEA). Its value for the goodness of fit ranges from 0.03 to 0.08. the RMSEA value for our study is 0.054, indicating a good fit for the model.

Table (5): Parsimony adjusted measures.

Model	PRATIO	PNFI	PCFI	RMSEA	LO 90	HI 90	PCLOSE
Default	0.500	0.496	0.499	0.054	0.000	0.125	0.433
Saturated	0.000	0.000	0.000	0.000	0.000	0.000	0.000
independence	1.000	0.000	0.000	0.478	0.441	0.517	0.000

Hypothesis Testing

Table 6 shows that value of the coefficient of regression for intelligent dashboard and QFD is 0.354 with a significant p value, while Standardized estimate is 0.362. The values show that there is a positive and significant relationship between ID and QFD. Hence, H1 is accepted. Regression coefficient value between MPM and QFD is 0.335with a significant p value. The standardized estimate is 0.327. It means that a positive and significant relationship exists between manufacturing process miners and QFD and H2 is accepted. Regression coefficient between QFD and PD is 0.800 at significant p value while the standardized estimate is 0.822 which is also significant and indicates that there is a positive and significant relationship between QFD and PD and H3 is also accepted. Similar findings were reported by Al-Maamouri & Al-Mousawi (2009) and Erdil & Arani (2019) who concluded that QFD is a methodical method of development of product and ongoing process improvement via conversion of customer needs.

The goodness of fit of has exhibited that quality function deployment play mediating role in influencing the impact of agile operation management in product development. And H4 is accepted. Additionally, Dovelike et al. (2020) discovered that the product process in IT startups is accelerated by the QFD integrated agile strategy.

Table (6): Regression weights.

	Est.	Std. Est.	S. E	C.R	p- value
ID → QFD	0.354	0.362	0.052	6.510	0.000
MPM → QFD	0.335	0.327	0.053	6.044	0.000
QFD → PD	0.800	0.822	0.037	21.223	0.000

Conclusion

Though they guarantee a dynamic and solid a development, ideas like agile operation management might become more popular in the present market, where customers are expecting quicker and more integrated solutions. Our research looked into how its social and technological aspects may be used in the manufacturing sector, which is one of the oldest sectors in the world. These ideas might be useful in this industry, according to the literature research on the topic. As a result, a questionnaire was used to conduct an empirical analysis for 26 businesses in the industry, and SPSS and AMOS-22 software were used to evaluate the results.

It may be inferred from the data that using agile operation management approaches with mediating role of quality function deployment in the Jordanian manufacturing sector has a positive impact on total product development. The two main modules intelligent dashboards and manufacturing process miners of agile operation management positively impact quality function deployment. The link between agile manufacturing and product development is the same, as stated by Stare (2014). Consequently, the industry's organizations will be sustained. Furthermore, it was shown that the efficiency and efficacy of product development are increased when agile operation management is mediated by the deployment of the quality function. This was also found by Dovleac et al. (2020) in his research.

The research gave manufacturing organizations a better understanding of what their customers needed and helped them schedule the completion of technical features so that products could be delivered on time. Our research provides a tool to comprehend the application of agile operation management principles in the industrial sector. Even if it has a number of contextual and conceptual flaws, this may also be a tool for experts and future researchers to explore and broaden the body of knowledge. To conceptually describe the consequences of AOM in product development, we have just considered one mediatory variable: the deployment of the quality function.

The operation management and quality management processes and tools used by Jordan's manufacturing industry are covered in our study, and it may be expanded to include other features. The potential implementation of a risk management system would be a particularly intriguing factor to take into account. The risk management model could aid in revealing the development team's competencies, which might then result in a modification of the QFD model. Owing to capacity limitations, we were unable to thoroughly investigate every aspect of the issue that would have yielded more insightful data. If the firm decides to switch operation management models later on in the decision-making process, more research into Agile framework implementation techniques may prove helpful. Other factors to take into consideration for more research include incentive strategies, corporate culture change, and resistance to change, as altering a well-known operation management approach involves a significant process of change management.

So as to guarantee the success of the new framework and that the Agile model is enthusiastically embraced by the workforce while preventing a reversion to previous practices, it is also important to closely examine the subject of "How to make sure employees follow procedures. The research will also examine how businesses decide which models to use—traditional, agile, hybrid, merged, or customized—and how they make this decision (Project Management Institute, 2017). Examining this matter may prove beneficial in determining the kind, character, and severity of a potential shift.

Disclosure Statement

- **Ethical Approval and Consent to Participate:** Not applicable.
- **Availability of Data and Materials:** All relevant data and materials are available
- **Authors' Contributions:** This work was solely authored by the researcher.
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