Implementation of DevOps metrics in Startups for scalable innovation

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Abstract: - The paper analyses the role of DevOps principles and metrics in the scaling process of Startup businesses. Startups, identified as key drivers of innovation and economic well-being, have faced challenges regarding the scaling processes once product-market fit is achieved. In order to address this issue, frameworks have been developed and proposed for implementation, but most of these are focused on Startups operating in the health sector. In the current paper, the author proposed a framework for scaling innovation in Startup businesses, regardless of their sector of activity. The model integrates key concepts from the DevOps software development lifecycle methodology and key metrics to help provide a basis for evaluating performance and making further improvements. The proposed model combines early-stage experimentation with later-stage scaling strategies and incorporates DORA metrics for evaluating performance.

Key-Words: - Startup, innovation, scaling, DevOps, Scaling frameworks, DORA metrics

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1 Introduction

Startup businesses have been identified as key contributors to the economic well-being of a country and the innovation ecosystem. One of the main concerns of Startup businesses is the achievement of a scalable business model that meets customer demands, which is to say, these businesses focus not only on bringing new solutions to the market but also on doing this in a manner that is scalable and economically sustainable. Scaling innovation has been however a particular challenge for Startup businesses offering disruptive technologies as solutions, and while frameworks for mitigating this exist, most are focused on health innovations in the health sector. One framework for scaling innovation in technology-based Startups has been identified in the literature and has furthermore been used as a starting point for the current research. The analyzed research proposed a framework for scaling innovation for technology-based Startups that have already achieved market validation but included no metrics for evaluation.

DevOps has evolved as a software development methodology that integrates the teams of development and operations activities, and aims to help shorten development cycles, improve collaboration, and ensure quality. One of the most frequently emphasized aspects of DevOps is the automation, continuous integration and delivery, and infrastructure monitoring. For this, DevOps relies heavily on metrics to help assess progress and performance. Some of the most commonly used and implemented metrics are known as DORA metrics (Deployment Frequency, Mean Lead Time for Changes, Change Failure Rate, and Mean Time to Recovery), which are a set of four metrics used for gaining insights into the technical efficiency of the development team, but also monitor customer satisfaction and product reliability.

The current paper proposes a scaling innovation framework adapted for the needs of Startup businesses and which is based on the DevOps cycle and DevOps metrics, in order to ensure that the Startup is making data-driven decisions when scaling. The model is divided into two main areas: Early-stage development focused on market opportunity identification, Minimum Viable Product development, and establishing release pipelines, and Growth-stage development focused on scaling strategies and feedback integration. This, paired with DORA metrics for each stage, could provide a direction for Startups looking to scale innovation.

2 Research background

Startup, the term which was first used in 1976 to describe a budding company [1], has gained massive popularity after the dot-com bubble of 2000, when the market witnessed an increased number of startups emerging [2]. The key target of any startup company

is not only to provide a new product that is required on the market, but also to do that in a manner that ensures scalable and economically sustainable development [3],[4].

Startups have been identified as key players in the innovation process ecosystem [5],[6] and it is in this context that the current paper analyses the impact of DevOps metrics in Startups in order to facilitate the innovation process.

Scaling can be seen as the extent to which an innovation is used with good effect in the entire population of interest. [7] It can be, therefore, argued that in the case of Startups - or at the very least those which provide disruptive technologies as their solutions- scaling can quickly become a concern.

Scalable innovation, referring to the process of scaling innovation, involves a strategic, proactive, and deliberate approach to spreading innovation. [8] An approach to facilitating this process is the use of theoretical frameworks for scaling innovation. But prior to choosing a theoretical framework, it is important to first understand the type of scaling that the organization is aiming for and the drivers of scaling.

Scaling innovation can refer to simultaneous processes of upscaling (creation of conducive conditions and policies for scaling at higher levels), outscaling (spreading of something within the same sphere), and downscaling (adaptation of existing practices, most often in a way that refers to reduction). [9], [10], [11]

As for the issue of drivers that lead to scaling, it can be summarized that two main drivers can lead to efficient scaling: changing conditions at higher levels or in other spheres, and leveraging points from which major influence can be exerted. [9]

Regarding the type of tools used for assessing the scalability of innovations, the literature is scarce, with the main focus being targeted towards the scalability of such innovations in the health sector [12].

In the context of this lack of research regarding scalable innovation in other sectors of activity or for different types of organizations, the current paper aims to address a small part of the research gap, for the case of Startup companies.

DevOps, a software development approach named after the combination of the two teams of any software project, development and operations, is a methodology that emphasizes automation (for both development and deployment) and infrastructure monitoring, along with a change in the company culture towards embracing collaboration between development, quality assurance, and operations teams. [13]

DevOps has a particular set of Key Performance Indicators (KPIs) to help integrate all of the aforementioned aspects, and in order to measure the outcomes.

There are more approaches as to which key metrics are the most important or useful in DevOps. One such approach suggests using 12 common KPIs for DevOps to keep the project on track: deployment frequency, change lead time, change volume, failed deployments, defect volume and escape rate, mean time for detection, mean time to recovery, feature prioritization, unplanned work, rate of security test passes, SLA compliance, and application performance. [14] Others argue that some Scrum metrics could prove useful for integration in the DevOps development process. These metrics include: velocity, work capacity, focus factor, percentage of adopted work, percentage of found work, accuracy of estimation, accuracy of forecast, targeted value increase, success at scale, and win/loss record. [15]

DORA, or DevOps Research and Assessment metrics, is a set of four measurements identified as being the most strongly correlated with success. The four metrics are:

- Deployment Frequency (DF) – measuring the frequency at which code is successfully deployed to a production environment, is considered a good indicator of customer retention and how well the automated testing and validation system works.
- Mean Lead Time for Changes (MLTC) – used for measuring how long it takes for a change to reach a production environment. When the desired results are not reached, the teams might choose to focus on key aspects such as analyzing metrics corresponding to the stages of their development pipeline (such as Time to Open, Time to First Review, and Time to Merge) to identify bottlenecks and opportunities for improvement
- Change Failure Rate (CFR) – a metric used for measuring the percentage of deployments that can lead to failure in production. This metric is a good indication of the quality of the code delivered, and when the metric is not reaching the expected goals, teams can look at reducing the work in progress in the iterations, increasing the efficacy of the code review process, or even investing more in automated testing
- Mean Time to Recovery (MTTR) – a metric used to measure the time required to restore a system to its usual functionality. This metric can be improved, if necessary, by improving the observability so failures can be quickly identified and resolved, having an action plan for responders to

consult, ensuring the team understands the process for addressing failures, and improving MLTC. [16]

In the case of startups, scaling emerges as soon as product-market fit and market validation are reached, and it involves a period of rapid growth when the user base is increased, but without increasing the commitments in resources and skills proportionally [17].

It is in each stage of a startup's lifecycle that KPIs and tools from DevOps can be implemented in order to facilitate the process of scaling innovation.

3 Methodology

At its core, the DevOps methodology relies on a set of practices that aim to ensure quality while minimizing the time between committing a change and it being deployed in production. [18]

The key tools of DevOps rely on continuous integration/continuous delivery (CI/CD) pipelines, highly automated orchestration and configuration solutions for the runtime environment [19] along with the set of four DORA metrics: Deployment Frequency, Mean Lead Time for Change, Change Failure Rate, and Mean Time to Recovery. [16]

The DevOps lifecycle process can be observed in Figure 1, and it can be noted that it follows the incremental approach of Agile methodologies, with activities such as Planning, Coding, Building, Testing, and Releasing, being followed by Deployment, Observations, Monitoring, and looping back to the Planning stage.

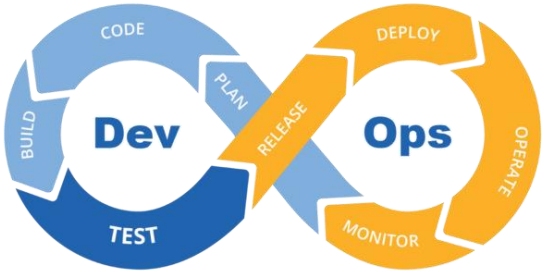

Fig. 1: DevOps process (
Source: [20])

The proposed framework maintains the core idea of the DevOps cycle and proposes the implementation of DevOps metrics for each stage of the development process.

Fig. 2: Startup scaling process [21]

Regarding the scaling process, especially in the case of startups, the current framework is based on the "Startup Lifecycle Scaling" model (presented in Figure 2) of Steve Blank, who proposed a three-step approach to scaling startups:

- Searching for a repeatable and scalable business model and achieving a product/market fit,
- Building the products in a manner that allows the achievement of a positive cash flow and/or generates users at a rate that can be monetized
- Growing – a phase in which the startup achieves liquidity and focuses on growing by repeatable processes. It is in this stage that a full set of KPIs for products and processes is in place [21]

Another model which was taken into consideration for building the proposed framework is that of Sanasi et.al., who in their paper proposed a model of experimentation for scaling in the case of technology-based startups. The model is composed of two main components: "Scaling opportunity identification" and "Experimentation for scaling", each with a subset of activities for achieving these goals and following a logical structure of building the roadmap, running the experiments, analyzing the results, and revising the initial strategy. [17]

4 Results

The proposed model for scaling innovation in Startups is based on using core DevOps metrics, such as the DORA metrics, for optimizing the scaling process and ensuring measurable and actionable steps are being taken.

The proposed model can be seen in a simplified form in Figure 3, where the correlation between the DevOps lifecycle stages and the startup scaling process stages is highlighted.

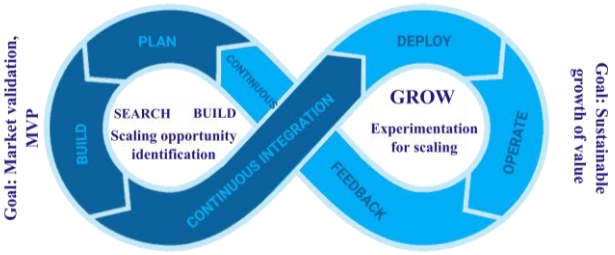

Fig. 3: Startup innovation scaling model

As can be observed from Figure 3, the proposed model integrates the main concepts from both the Startup scaling process as well as a model for scaling innovation in technology-based startups while encompassing the information in the DevOps software development lifecycle. As a result, the model consists of two main categories of activities

and concerns: one focused on identifying market opportunities and building products that can be tested on the market, and another focused on growth and experimentation for scaling. While the main goal of the first (left) part of the proposed model is obtaining market validation and building a Minimum Viable Product (MVP), it can be observed that the second part (right) focuses mainly on growth opportunities, experimentation for scaling, with the main goal being that of achieving sustainable growth of value.

These pieces of information alone, however, couldn't address the underlying issue regarding the techniques and tools that could be used to measure the impact of each activity and the efficiency of the development team and the development process itself. Therefore, the integration of DORA metrics has been proposed and presented in Figure 4.

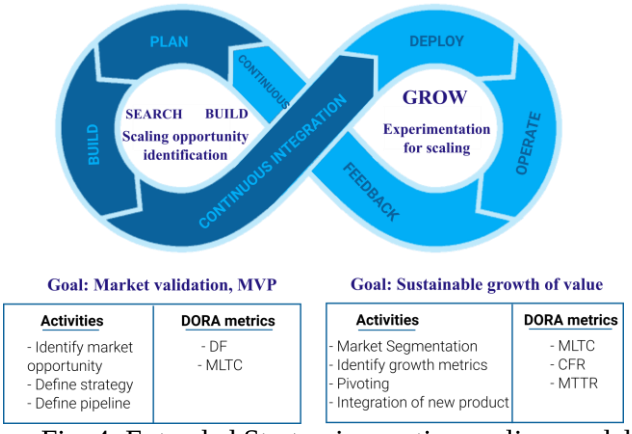

Fig. 4: Extended Startup innovation scaling model

Figure 4 shows how the main goals and roadmap of the scaling model of technology-based startups are aligned to the vision of the proposed model, and depicts the set of actionable steps and DORA metrics recommended for each stage of the scaling process.

The figure presents the integration of key activities related to each goal of the model and DORA metrics. In this case, DORA metrics are enforced as gatekeepers to ensure the decisions made for the scaling process are data-driven and provide useful insights from the development process. As can be noticed, in the first part of the model, where the goal is mainly related to achieving a product/market fit, the key activities include identifying market opportunities or issues present on the market that can be addressed, defining adequate strategies for reaching the goals, and establishing functional release pipelines. There are two DORA metrics suggested for this stage: Deployment Frequency and Mean Lead Time for Changes. Both of these metrics are aligned to the general goal and main idea of this stage and support the rapid development of MVP's which can be tested on the market.

For the second part of the model, focused on achieving sustainable growth of value and experimenting for scaling, key activities include: market segmentation and identifying key target customer segments, identifying the growth metrics and monitoring these key metrics constantly, acquiring customer feedback and devising action plans based on these such as identifying solutions to customer complaints or choosing to pivot to meet a previously unknown customer requirement, and activities related to the integration of new products or integration of new functionalities into the new products. As for the DORA metrics suggested for this stage, metrics such as Mean Lead Time to Change, Change Failure Rate, and Mean Time to Recovery can help sustain the efforts required to meet the established goals.

An important concern to be addressed is related to the possibility of including performance thresholds for the transition from the Build phase to the Grow phase for a startup. A possible approach to this could be including a set of thresholds for each DORA metric, following the model presented by Google in the "DORA Accelerate State of DevOps" report of 2024. [22] In their report, four levels of performance are established (low, medium, high and elite) based on the analysis of the DORA metrics (for instance, an elite performer would have a change lead time of less than one day, a deployment frequency of multiple deploys per day, a change fail rate of 5% and a failed deployment recovery time of less than one hour).

Table 1. depicts an approach to establishing a set of metrics inspired by the Google model to be used for startups in order to help determine the threshold for the transition from the Build stage to the Grow stage

Table 1. DORA thresholds for stage transition

Stage	DORA metric	Threshold	Characteristic
Build	DF	More than one per week	Stable pipeline, ready for growth
	MLTC	Less than seven days	
Grow	CFR	Less than 20%	Mature delivery, sustainable scaling
	MTTR	Less than a day	

As it can be observed from Table 1, the main four metrics considered were adjusted according to the Google DORA metrics for high performers,

therefore, a DF of more than one per week and a MLTC of less than seven days could indicate a stable pipeline which is ready to sustain the growth, while a CFR or 20% and a MTTR of less than a day show a mature delivery process that is adequate for sustainable scaling.

Another important aspect to be considered is the generality of the proposed model, and the ability to mold it in order to meet the requirements of startups that are not focused on delivering software products. While including a full set of DORA metrics equivalents for startups from all sectors of activities is difficult, making clear delimitations and proposing a set of standardized metrics could help practitioners understand the core idea of DORA metrics and choose to implement the standard metrics that could benefit their startup or even define a new set of metrics that is shaped according to the needs of the startup.

Table 2. shows a set of standardized proposed metrics for non-software startups

Table 2. DORA equivalents for non-software contexts

DORA metric	**Software context**	**Equivalent in a non-software context**
DF	No. of successful code deployments	Frequency of new product releases
		Process rollouts
		Operational updates
		Frequency of updates (to the product, to the pricing strategy)
		Frequency of updates based on customer feedback
		Frequency of new service feature launches
MLTC	Time from code commit to deployment	Time to validate the idea/design change to implementation
		Time from customer trend detection to store execution
		Time between supplier product updates and availability to customers
		Time from policy to staff implementation
		Time from customer complaint to corrective measures
CFR	% of deployments causing failures	% of new releases or process changes requiring rework
		% of new product introductions that result in inventory errors
		% of operational changes (i.e., pricing, logistics) that lead to a drop in sales
		% of service updates (i.e., new procedure) that cause customer complaints
		% of internal process changes that require rework or rollbacks
MTTR	Time to restore service after failure	Time to restore production/service continuity after the disruption
		Time to restore operations after system downtime
		Time to fix e-commerce platform issues
		Time to recover sales levels after a failed campaign or supply disruptions
		Time to resolve issues affecting customers (i.e., billing errors)
		Time for customer satisfaction metrics to return to normal levels after an incident

The model should, of course, not be implemented rigidly, and if deemed necessary, other DevOps metrics should be included and/or some of the proposed ones should be excluded, according to the particularities and preferences of the Startup. The goal of the proposed model was to provide a starting point, grounded in research, for helping Startups address the scaling process, and which could then be adapted according to the needs of the Startup or the development team.

5 Conclusion

Startup businesses have been identified as key contributors to the well-being of the economy, as well as contributors to the innovation process ecosystem. A key issue for many Startup businesses is related to achieving a product that meets the product/market fit, meaning a product that the target customer segments are willing to pay for. Furthermore, Startup businesses must quickly adapt once they reach a product/market fit to secure a scalable and repeatable business model.

When it comes to the innovative results obtained by Startup businesses, scaling must be taken into account. Scaling refers to the extent to which an innovation is used for the entire population of interest, while scaling innovation must take into account activities related to the strategic, proactive, and deliberate approach to spreading innovation and

encouraging the implementation and usage of the innovation. One important aspect to remember is that scaling innovation can involve both upscaling and downscaling practices.

Startup scaling has been analyzed in literature in the context of the Startup's lifecycle with three main stages: the search for a repeatable and scalable business model, building the products that meet customer demands, and growing the process while implementing a set of KPIs for performance measure and for building a base for future improvements. Another proposed model for scaling innovation in technology-based Startups, focusing on two main directions: scaling opportunity identification and experimentation for scaling. This model, however, does not integrate any sort of KPIs or metrics to help evaluate the impact of the activities and provide a basis for future comparison regarding the obtained results. In this context, in the current paper, a model inspired by these previous two has been developed to help address the issue of scaling innovation in Startup businesses. The model relies on key principles of the DevOps software development methodology and includes some of the most useful DevOps metrics – DORA metrics to help provide a basis for concrete measurements and evaluation. The model is divided into two main parts: one part focused on identifying the business model and product that can reach the product/market fit, and a part focused on growth, scaling, and improvement. These parts correlate with the DevOps cycle and include key activities and key DORA metrics for each segment.

Additionally, in order to support the implementation of the proposed model for Startups from non-software development environments, in the current research paper, a set of alternative or equivalent metrics is suggested, which can, of course, be altered according to the particularities and necessities of the Startups using the model. Furthermore, the model also provides an intuitive and short guide to help identify the adequate time a Startup can move from a build phase of the lifecycle model to a Growth stage. This is done through the help of the DORA metrics, with metrics tailored for Startup businesses. One limitation of the study is the lack of practical application of the proposed model on at least a real Startup business in order to better understand if the model needs adjustments and how it could be improved in order to better serve the needs of Startup businesses aiming to scale their innovations. In this regard, future research directions could include the implementation of the proposed model in the case of various Startup businesses, and of different sizes, in order to gather feedback and better understand how the model can be shaped to meet the requirements of these types of businesses. Additionally, further research could focus on calibrating the performance thresholds for the established DORA metrics in order to define scaling readiness in a more precise manner, as well as exploring the possibility of integrating the proposed framework within other management approaches, such as Scrum development, Lean startup, and so on.

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The author contributed in the present research, at all stages from the formulation of the problem to the final findings and solution.

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