



START-UP SUCCESS: PIECING TOGETHER THE PRODUCTION PLANNING PUZZLE

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ABSTRACT

During their critical growth phase start-up organizations often face challenges in achieving their production targets. This is due to frequent interruptions in production flow. This article addresses this issue by presenting a conceptual framework of considerations for use when designing production plans that contribute to proper resource allocation during this crucial period. A rapid literature review was conducted to investigate existing strategies and key factors for scaling a start-up organisation's production. The findings of the literature review have been combined into a framework for developing effective growth production plans for start-up organizations. By considering these factors, start-up production organisations can accelerate their progress towards their goals.

Keywords: production planning, resource allocation, start-ups

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1 INTRODUCTION

All organisations, small or large, have to start somewhere. At one point in time any organization was a so-called “start-up organization”. According to Shane and Venkataraman (Shane & Venkataraman, 2000), (“s)tart-ups are newly formed organizations that are trying to achieve market-oriented objectives under conditions of extreme uncertainty.” During these uncertainties, a production plan is critical for the up-scaling endeavours of the production start-up organization attempting to reach its targets. Different components have been identified that are required in production plans, although not all production plans contain all of these components. Examples of these are 1) a bill of materials, 2) facility layout and 3) labour and assembly schedule. In the context of a production start-up organization that is in its very beginning stages, these production plans must be meticulously crafted to meet the organization’s requirements, starting from ground zero. Also, when a start-up organization decides to enter the upscaling phase, its current resources have to be considered in addition to the goal they would like to reach. Problems that are common to most start-up organizations are:

- Cashflow is limited - creating a pressing need to allocate and spend funds effectively in order to grow the organization and ensure that it becomes a significant contributor to its market.
- Standardising quality, followed by the implementation of quality control practices that allow for continuous improvement, while balancing production costs with quality considerations.
- Managing market uncertainty because the start-up organization is not established or yet well-known.
- Developing policies to confront unexpected challenges like equipment failures, supply chain delays or unforeseen demand fluctuations, and the need to build an organizational culture.

According to [1], entrepreneurs experience more extreme emotions than the general population, and their study explores and highlights the role of emotional regulation in a new venture’s success. Some of the negative emotions that [1] mentions, are “high levels of information overload, uncertainty, time pressure, fatigue, and strong emotions, both negative and positive.” Cognitive reappraisal (“changing the way we see things”) is a focal point in their study, as it is one of the “most well-established and researched types of emotion regulation”. The role of information overload and uncertainty is significant due to the fact that there is such a plethora of factors to consider when building a new organisation. All of these factors lie before decision makers like scattered puzzle pieces. While the end vision is crystal clear, decision makers have no idea where the puzzle pieces fit, or even which pieces should be used.

The aim of this study is to develop a framework to be used by start-up organizations to develop a production plan during their critical growth phase, where proper resource allocation is key. A Rapid literature Review (RR) was used to investigate the factors to consider. The framework developed will fuse different considerations during the critical growth phase into a logical and easily visualised format, thereby mitigating the problem of information overload and uncertainty. To this extent it offers an approach that is step-wise, over-arching and foundational, thereby giving the leadership figures at new organisations a clear structure to follow. The framework will help decision makers to identify, and make sense of, the pieces that are necessary to build the puzzle.

To achieve this aim, a rapid literature review was conducted to identify the considerations (Section 2). Section 3 presents the findings from the RR. Section 4 presents the combined design. The conclusions drawn from the study and the proposed future research are presented in Section 5 and 6, respectively.





2 RESEARCH METHODOLOGY

According to (Speckemeier, Niemann, Wasem, Buchberger, & Neusser, 2022) “(a) rapid review (RR) is a form of knowledge synthesis that accelerates the process of conducting a traditional systematic review through streamlining or omitting a variety of methods to produce evidence in a resource-efficient manner”. The aim of this rapid review is to investigate the considerations when developing production plans for start-up organizations during their critical growth phase, where proper resource allocation is key.

Table 1: Research protocol followed in the RR

Purpose of the study	To investigate and develop a list of considerations for developing a strategy for designing production plans for start-up organizations during their critical growth phase, where proper resource allocation is key.
Keywords	“production startup” AND “growth strategy”
Search databases	• Emerald Insight • Web of Science • IEEE Explore • Scopus • EBSCOHOST
Inclusion criteria	• Production plan - literature • Entrepreneurship - literature as well as startup literature • Literature about non - digital production processes.
Exclusion criteria	• Technology-focused or quality control-focused literature • Literature pertaining to chemistry, biology, materials, energy, politics or economics. • Literature focused on geography, environment and sustainability. • Literature pertaining to financing, modelling, sales or marketing. • Literature that only mentions the keywords but does not consider further growth strategies. • Literature that discusses aspects of entrepreneurship and startup organizations, other than growth strategies for startup organizations. • Industry-specific literature. • Non-English literature.
Quality assessment criteria	• Studies should be published in English. • Repeatable and reputable scientific research methods should have been followed.

The literature search was conducted between May and June 2023.





The RR steps listed below have been used in this study (Speckemeier, Niemann, Wasem, Buchberger, & Neusser, 2022).

1. Develop a research purpose/objective.
2. Develop a research protocol.
3. Establish relevance criteria.
4. Search and retrieve the literature.
5. Selection of studies: screen for relevance criteria.
6. Quality assessment of relevant studies.
7. Data extraction.
8. Analysis and synthesis of findings.
9. Reporting.

2.1 Step 1: Develop a research purpose/objective.

The aim of this study was to investigate the considerations to be taken into account when developing a production plan for start-up organizations during their critical growth phase, where proper resource allocation is key.

2.2 Step 2: Develop a research protocol.

The research protocol that was developed during this RR is illustrated in Table 1.

Step 3: Establish relevance criteria

The inclusion and exclusion criteria were established and used to determine which articles were relevant to the current study (Table 1). The exclusion criteria were drawn up as the review was conducted, and categories of topics were identified that yielded results to the search, but did not contribute to achieving the purpose of the study, and literature that mentioned the keywords, but explored tangential or industry-specific topics instead. Non - English literature also had to be excluded due to the language barrier presenting an obstacle in comprehension of the literature in that category. The inclusion criteria were identified as the categories of topics of which the literature must be a part in order to be capable of rendering useful and relevant information.

3 FINDINGS FROM RAPID REVIEWS

The databases were searched according to the protocol that had been outlined previously and relevant literature was identified and retrieved. Section 3.1. shows how the screening process was conducted from the literature that had been identified initially. Section 3.2 shows which literature was rejected and which of the accepted studies overlapped in different databases, while section 3.3 gives more detail regarding the quality assessment criteria and section 3.4 presents a summary of the findings from the rapid literature review.

3.1 Step 4: Search and retrieve the literature

Step 4 of the protocol was to search and retrieve the literature. A total of 535 studies were found (refer to Table 2). The first phase of the study selection (Identification) shows the studies that were found in each of the listed databases prior to the commencement of screening. This phase corresponds with Step 4 of a RR, as given in (Speckemeier, Niemann, Wasem, Buchberger, & Neusser, 2022). The second phase of study selection involved screening the literature for relevant criteria, corresponding with step 5 in (Speckemeier, Niemann, Wasem, Buchberger, & Neusser, 2022). The eligibility phase overlaps with step 5 in (Speckemeier, Niemann, Wasem, Buchberger, & Neusser, 2022), but is shown distinctly in the table to indicate that the identified studies are eligible and do not contain duplicate information.





Table 2 gives an overview of the phases described above.

Table 2: Process of selecting the studies used in this RR

Phase of study selection	Studies found in each database
Identification	• Emerald Insight: 230 • Web of Science: 96 • IEEE Explore: 3 • Scopus: 200 • EBSCOHOST: 6 Total studies found: 535
Screening	• Emerald Insight: 2 • Web of Science: 3 • Scopus: 1 Total studies found:3, as all of them overlap between different databases to an extent. For more details, refer to Figure 1.
Eligibility	After eliminating duplicates, the total studies remained 3.
Quality	Total studies to be used: 3

3.2 Step 5: Selection of studies

After applying the inclusion and exclusion criteria to ensure relevance, only three titles have been selected as relevant. Table 3 gives a break-down of how the search results were filtered, and how the rejection criteria were applied. The first two reasons for rejecting papers were inaccessibility from within the database, and papers that were duplicates. Rejection reason numbers 3 - 5 and 8 - 17 in Table 3 state in summary that they focus on topics other than start - ups. Reason number 6 discusses entrepreneurship and start-up related topics but does not dive into growth strategies for production startup organisations, while reason 7 only mentions the keywords as a means of describing the organisation discussed in the papers involved, without engaging in further discussion regarding growth strategies.

In the right-hand column, the total number of articles that were rejected for each of the reasons given in the left-hand column, is given. The last three rows of the table calculate the total articles rejected per database, the number of articles that were found in each database and the number of articles that were accepted for this study. This is the result of subtracting the number of articles that were rejected from the number of articles that were found.



Table 3: Break- down of rejection quantities and rejection reasons for each database that was searched

Number of papers rejected							
Database		IEEE Explore	EBSCOHOST	Web of Science	Scopus	Emerald Insight	
Nr.	Rejection reason						Total
1	Not accessible		2				2
2	Duplicates				1		1
3	Technology- focused	2		1	2	15	20
4	Quality control- focused	1					1
5	Geography- focused		1				1
6	Start- ups, but not in- depth about growth strategies		1	1	1	178	181
7	Keywords only describe organisations		2				2
8	Chemistry- focused			35	10		45
9	Economy- focused			5	2	4	11
10	Biology- focused			45	7		52
11	Environment and sustainability- focused			2	1	4	7
12	Energy- focused			1	1		2
13	Materials- focused			1	1		2
14	Financing- focused			1	2	10	13
15	Modelling- focused			1	1	4	6
16	Sales or marketing- focused				1	11	12
17	Politics- focused					2	2
	Total rejected per database	3	6	93	30	228	360
	Total articles found	3	6	96	31	230	366
	Total articles included	0	0	3	1	2	6

Of the articles found, Fine, Padurean and Naumov (Fine, Padurean, & Naumov., 2022) was found in Web of Science as well as Scopus, while McDonald, Shalloo, Pierce and Horan (McDonald, Shalloo, Pierce, & Horan, 2013) and Solaimani, van Eck, Kievit and Koelemeijer (Solaimani, Eck, Kievit, & Koelemeijer, 2022) were found in both Web of Science and Emerald Insights, as shown in Figure 1. Therefore, only 3 articles were accepted in this RR.

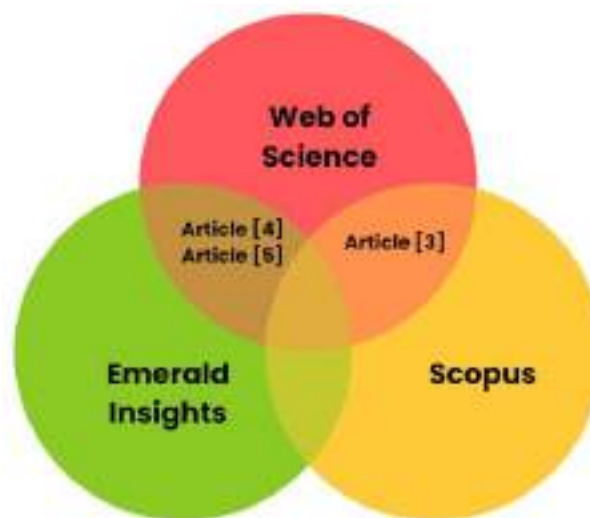


Figure 1: Venn diagram of studies overlapping in different databases



3.3 Quality assessment

The full text of each of the 3 selected studies was read to assess the quality of these texts. The quality phase corresponds with step 6 of (Speckemeier, Niemann, Wasem, Buchberger, & Neusser, 2022) and the studies conducted in the remaining papers have followed reputable and repeatable scientific methods. This step is of critical importance and ensures that only literature of acceptable quality, and therefore validity, is selected for inclusion.

3.4 Summary of findings

Table 4 gives a summary of the data that has been extracted from the abovementioned literature studies.

Based on the findings from the RR, the following are factors to be considered when designing a production plan for a start-up organization. The details of each factor are discussed as part of the concept design (Section 4).

- Risk (McDonald, Shalloo, Pierce, & Horan, 2013)
- Profitability (McDonald, Shalloo, Pierce, & Horan, 2013)
- Cashflow (McDonald, Shalloo, Pierce, & Horan, 2013)
- Practicality (Solaimani, Eck, Kievit, & Koelemeijer, 2022)
- Processification (Fine, Padurean, & Naumov., 2022)
- Professionalisation (Fine, Padurean, & Naumov., 2022)
- Culturalisation (Fine, Padurean, & Naumov., 2022)
- Automation (Fine, Padurean, & Naumov., 2022)
- Segmentation (Fine, Padurean, & Naumov., 2022)
- Platformisation (Fine, Padurean, & Naumov., 2022)
- Collaborations (Fine, Padurean, & Naumov., 2022)
- Capitalisation (Fine, Padurean, & Naumov., 2022)
- Replication (Fine, Padurean, & Naumov., 2022)
- Evaluation criteria (Fine, Padurean, & Naumov., 2022)

4 CONCEPT DESIGN

The factors discussed in Section 3 have been combined into a pillar diagram (Figure 2). This diagram gives a structured overview of the order in which the factors should be considered. The pillar diagram consists of three levels: the roof, pillars and foundation. As in a house, each of these levels has an important and unique role and the factors have been structured into these 3 levels that correspond in function with the analogy of the house. The reasoning followed in grouping each factor in the associated level of the house is explained under its associated sub-heading in this section. The over-arching factors, which represent the roof of the house, have been indicated using an alphabetic numbering system to show their sequence, and to act as a reminder that these should be constantly considered with each decision, during an iterative process. This should be done in the same manner that the weight distribution of a roof should be considered when attempting changes to the pillars or foundation of a house in order to prevent the roof from collapsing. The pillar and foundational factors have been sequenced with Arabic numbers, indicating the order in which they should be considered. The foundational factors are sequenced first as they form the basic building blocks of the organisation, and everything else is dependent on them. If the foundation fails, the entire house will fall. Each of the pillars represent a different production plan element. Additional pillars could be added, or the current pillars could be replaced by others, but this literature review has focused on the 3 pillars that are shown here.





Table 4: Summary of the data extracted from the selected literature

Title	Authors	Year	Summary	Ref
Evaluating expansion strategies for startup European Union dairy farm businesses	R. McDonald, L. Shalloo, K. M. Pierce, and B. Horan	2013	The paper considers risk, profitability and cash-flow projections of different expansion strategies.	(McDonald, Shalloo, Pierce, & Horan, 2013)
Operations for entrepreneurs: Can Operations Management make a difference in entrepreneurial theory and practice?	C.H. Fine, L. Padurean and S. Naumov	2022	The paper posits that “operations tools can make a significant difference in the scaling stage” and a catalogue of 10 tools was developed for entrepreneurial scaling. These 10 tools are explained below: Processification: Well-defined processes have the advantages of enabling efficiency and repeatability, while allowing delegation and decentralisation. Professionalization: as the organization grows, more professionals with specialist-knowledge are appointed. Culturalization: “Building and maintaining a culture that supports the organization’s goals is critical to efficient scaling.” This process requires constant communication of the culture - with cultural reinforcements taking place during rapid scaling to mitigate the challenges presented by the number of new employees and partners. Automation Segmentation: exploring how to drive growth into adjacent or different market segments. Platformization: “utilizing a platform to exploit cross economies of scale from multiple customer segments or constituent groups” Collaborations Capitalization and the “dilemma of needing to give up significant control” in order to gain additional capital.	(Fine, Padurean, & Naumov., 2022)





Title	Authors	Year	Summary	Ref
			Replication of the process in different locations and settings, with or without modifications. Replication efforts' capabilities and outcomes must be documented and trained. Evaluation: making use of Key Performance Indicators with caution, to prevent stifling the organization's innovative spirit.	
An exploration of the applicability of Lean Startup in small non-digital firms: an effectuation perspective	S. Solaimani, T. van Eck, H. Kievit and K. Koelemeijer	2021	This paper confirms that non-digital entrepreneurs use effectual logic when applying the lean start-up approach and provide a “view on how different effectuation principles are at play”. It proposes that lean start-up practices should be “reconsidered in light of physical constraints and possibilities, but also, what skills and competencies need to be developed to employ LS in the most effective ways”. It further shows that contextualising the lean start-up approach to a non-digital environment “calls for a particular set of skills and competencies, including applying mixed-methods cross-validation, affinity and passion for craftsmanship and aesthetics, inferring from limited, qualitative, and often skewed, data, establishing an empathetic collaborative relationship with customers and suppliers, and leveraging prior market knowledge and experience.” Contextualising the Lean Startup approach with effectuation logic, while considering the physical constraints and possibilities, as well as the skills and competencies needed. The Lean Startup approach involves “accelerating product development and launch while maximising efficient use of available resources”. Effectuation, on the other hand, involves beginning with what you have, focusing on the acceptable cost, placing emphasis on “strategic alliances and pre-commitments”, leveraging environmental contingencies and attempting to control an unpredictable future.	(Solaimani, Eck, Kievit, & Koelemeijer, 2022)



The factors that have been placed in the pillars differ between pillars, as some factors will only have an impact on some, but not all, of the pillars. The reasoning of the factor-allocation under specific pillars, has been explained in section 4.2.

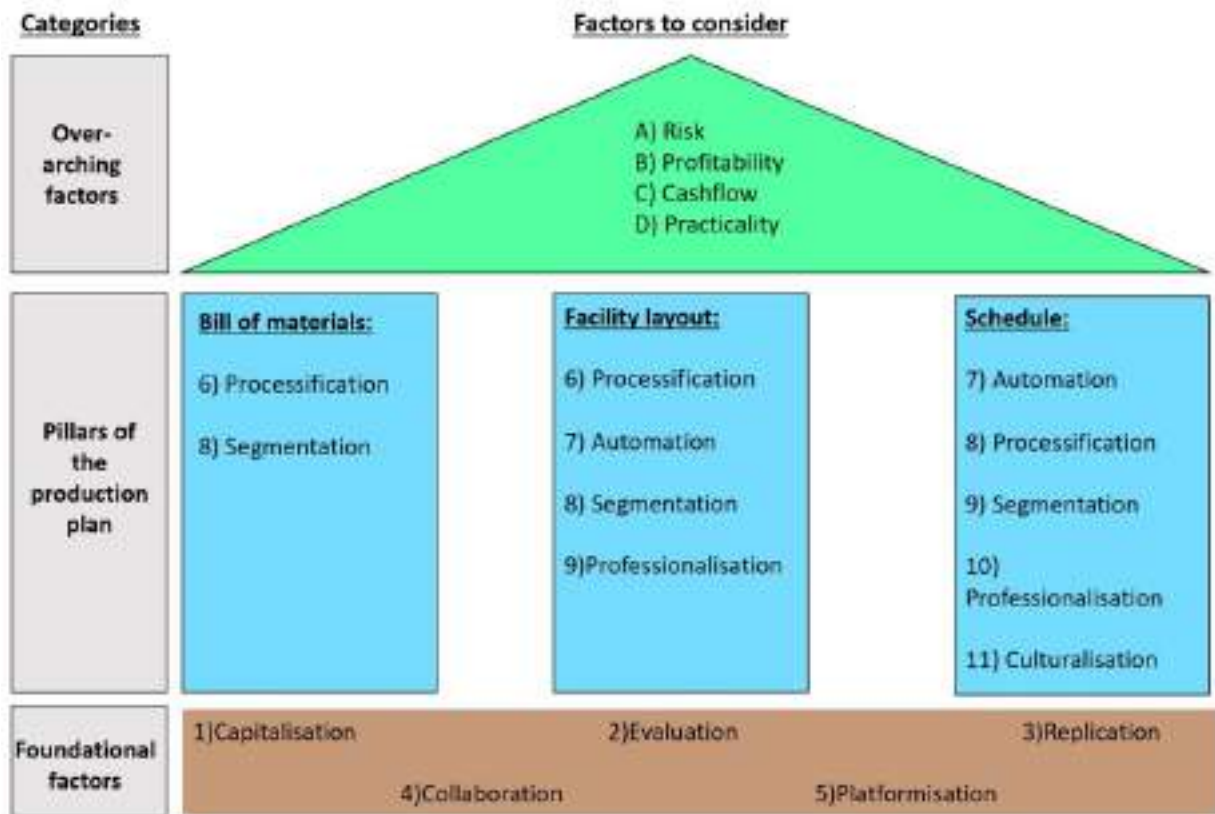


Figure 2: The house of considerations when designing a production plan to build your organization

4.1 Foundational factors

Starting at the bottom-left corner of Figure 2, the foundational factors should be considered first as they describe the decision-making process, role-players, and the objective(s) of the production plan.

4.1.1 Capitalisation

As the investment structure changes, the decision-makers might change as well. This factor, as well as the relationships between investors and the founder(s), will play an important part in determining how funds for the organization's growth will be obtained as well as the costs associated with obtaining funds. Examples of costs associated with obtaining additional funding include interest on loans and the fees associated with legally obtaining a different ownership structure (sole proprietorship/partnership/private company/public company). While this factor does not have a direct influence on the production plan, it influences the potential profitability of each alternative growth strategy that is considered.

4.1.2 Evaluation criteria

The evaluation criteria, requirements, and key performance indicators will influence every aspect of the production plan since the requirements and criteria are the foundation upon



which the production plan is built, and the key performance indicators and criteria are used to evaluate, improve and update the production plan in an iterative process over time.

4.1.3 Replication

The organization's vision will impact whether or not replication will be necessary. For example, whether the organization desires to open more factories in different locations around the country or around the globe, as well as all of the legal implications associated with such a decision. If an organization desires to grow to the extent that replication becomes necessary, the production plan should be designed with future replicability in mind, thereby saving the time of drawing up a new production plan for each replication that takes place.

4.1.4 Collaborations

Collaborating with other manufacturers or suppliers will have an impact on the production scheduling if it involves sending the work-in-progress goods to the collaborative partner at any stage of the process, or cutting down steps in the production process because the collaborative partner now supplies the organization with better-prepared raw material, such that the production organization no longer has to perform the preparation steps. This, in turn, will influence the facility and bill of materials, depending on the relationship between those steps in the production process (impacting the flow within the facility), and the material requirements involved in production.

4.1.5 Platformisation

Utilising platforms, or increasing platform use, could have a big impact on sales. Therefore, it could have an impact on the magnitude of the growth that the production plan aims to achieve, thereby affecting all three parts of the production plan.

4.2 Pillars of the production plan

In the middle of the framework (Figure 2), the pillars represent the different elements of the production plan and the factors that should be considered during the design process of each of these parts.

4.2.1 Processification

Defining and stabilising the production processes, as well as the quality standards of the product, is essential before any production plans for growth can be designed. This impacts the bill of materials since it impacts the quality standards agreed upon with suppliers, and the scheduling of activities within the assembly process and, correspondingly, the facility layout to ensure a good work-flow within the facility.

4.2.2 Automation

Automation is often a necessary consideration where upscaling and growth is concerned as automated procedures provide a more consistent level of quality, with less variation, and often at a higher production rate than manually completing the same procedures can provide. Productivity must be weighed against cashflow and financial risks, while considering legislation. The scheduling in the production plan will be most significantly affected by automation decisions, and the facility layout will also change with regard to these decisions, depending on the spatial requirements, noise levels and safety regulations associated with these decisions.





4.2.3 Segmentation

When adjacent or different market segments are explored as potential growth opportunities, the bill of materials, facility layout and schedule may all be impacted, depending on what additional products will be manufactured, and how much their production processes differ from the production processes currently in use.

4.2.4 Professionalization

During growth more specialist appointments are common, and this greatly impacts scheduling decisions as work will be distributed to the person who has the most expertise and/or experience in the relevant field to ensure that their talent is maximally utilised. It will also, to a lesser extent, influence the facility layout if it has an impact of the workflow-facility relationship.

4.2.5 Culturalisation

Building organizational culture is an important consideration when making hiring decisions, and therefore it impacts training and scheduling. The pace at which new employees are introduced to the organization must be properly managed to ensure that the organizational culture remains aligned to the founders' and stakeholders' vision, and to ensure a productive and positive working environment for employees.

4.3 Roof of over-arching factors

Lastly at the top, the roof represents the over-arching factors. These should be kept in mind all the time and will have an overarching effect on the design of the entire production plan. When making any decision the influence of the over-arching factors must be considered. An analogy can be drawn from this as the effect that a pillar's adjustment would have on the stability of the roof.

4.3.1 Risk

This factor considers the changes made to the organization's overall risk profile that occur with each decision in the production plan. Resource risks influence both the bill of materials as well as the scheduling agility required. An example of a resource risk is the risk of a particular brand of machine breaking down and causing production delays. Operational risks influence scheduling and facility layout considerations. An example of an operational risk is the risk of employee injury. Supply chain risks have an impact on the bill of materials and alternative supplier options, as well as on scheduling decisions. Legal and compliance risks, as well as talent risks when appointing new staff, influence scheduling. Reputational risks influence decisions with regard to quality compromises.

4.3.2 Profitability

Financial returns should be an important consideration. One of the tools that is useful in measuring the financial returns is Return on Investment (ROI). Projections and scenario analyses for different growth strategies that are practical for the specific context of the organization involved, that consider the profitability over time for a set investigation period, would also prove to be helpful in the process of determining the most profitable growth strategy that will be used in the production plan. Additionally, asset growth or decline should be factored into these calculations where applicable.

4.3.3 Cashflow

Business growth usually requires significant additional investment, causing an outflow of funds into assets. It is important that the cashflow of the organization must be sufficient to balance





these investments and prevent the organization's solvency and liquidity from being negatively influenced by these growth decisions. Failing to consider this factor could lead to bankruptcy. Therefore, cashflow is a critical consideration.

4.3.4 Practicality

Consolidating the Lean Start-up approach with the physical and practical constraints that the organization faces will influence all aspects of the production plan. Efficient fund allocation is important for a start-up's success as well as the success of any growth strategy and the Lean Start-up approach ensures that this aspect is considered. However, the physical and practical constraints of the organization must be weighed against the Lean Start-up Approach in order to determine, as far as possible, what the organization can achieve within the Lean framework. Physical and practical constraints include aspects like legislation, facility and storage constraints, and the employee productivity that can be reasonably expected.

5 CONCLUSION

From the literature obtained in the Rapid Review, it is observed that there are various factors that should be considered during the design of a production plan for a start-up organization. These factors are dispersed throughout different articles, like scattered puzzle pieces, and there is no combined list of considerations. The aim of this study was to develop a framework to be used by start-up organizations to develop a production plan during their critical growth phase where proper resource allocation is key. An RR was used to identify the factors to consider. The resulting framework can be likened to the outer frame of a puzzle, which is often built first, and then the puzzle can be built further because there is now a clear view of things that have to be kept in mind.

From the factors that were identified and gathered, a novel conceptual framework has been developed, producing a combined list of considerations, as well as the sequence in which they should be considered and visualised (Figure 2). This list unifies the research on the topic, giving an overview. This research therefore offers a combined set of considerations, reducing the time and effort required for start-ups to develop their scaleup production plans, and facilitating their success in a competitive market.

6 FUTURE RESEARCH

A limitation of this Rapid Review is that it has been conducted in a hurry and it is possible that an oversight could have occurred. Another limitation is the fact that this review has only been done on five databases. Future research could increase the databases so that more literature is covered. The keywords that were used in this review could be improved to include more studies and different variants of the keywords could be considered. Both of these improvements could result in an expansion of the list of considerations. Additionally, a production plan consisting of different, or more elements, than a bill of materials, facility layout and schedule may be required, and additional pillars can be added to Figure 2 for a more comprehensive view of different variations and elements of production plans. It should also be noted that the framework that has been presented in this paper is a concept design that has not yet been tested. Future research should involve testing and refining the concept design as necessary.





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