St. Petersburg University
Graduate School of Management

Master in Management Program

ENHANCEMENT OF OPERATIONS STRATEGY BUILDING METHOD UNDER DEMAND UNCERTAINTY

Master's Thesis by the 2nd year student Concentration — General Management Iaroslav Lukin

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АННОТАЦИЯ

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Название ВКР	Совершенствование метода построения операционной стратегии в условиях неопределенного спроса
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Описание цели, задач и основных результатов	**Цель исследования:** усовершенствовать существующий метод построения операционной стратегии в условиях неопределенного спроса посредством оптимизации планирования производства и принятия решений в рамках операционной стратегии адекватного реагирования и оценить эффективность предложенного совершенствования на примере компаний Sport Obermeyer и Un.lock. **Задачи исследования:** - На основе проведённого обзора научной литературы выбрать соответствующий метод построения операционной стратегии для усовершенствования; - Предложить усовершенствование выбранного метода посредством оптимизации планирования производства в рамках стратегии адекватного реагирования; - Реализовать применение усовершенствованного метода на примере кейс-компаний и оценить его эффект. **Основные результаты исследования:** - В качестве рассматриваемой операционной стратегии была выбрана стратегия адекватного реагирования на основе обзора литературы; - В рамках стратегии адекватного реагирования было выбрано планирование производства как рассматриваемый метод построения операционной стратегии - Для оптимизации планирования производства была сформулирована модель, использующая линейное программирование, стоимость полной информации (EVPI), и модель продавца газет; - Усовершенствованный метод был применен для оптимизации планов производства компаний Sport Obermeyer и Un.lock, где был выявлен положительный эффект.
Ключевые слова	Цепи Поставок, Операционная Стратегия, Неопределенный Спрос, Адекватное Реагирование, Планирование Производства, Стоимость Полной Информации, EVPI, Линейное Программирование, Модель Продавца Газет.

ABSTRACT

Master Student's Name	Iaroslav Lukin
Master Thesis Title	Enhancement of operations strategy building method under demand uncertainty
Educational Program	Master in Management – MiM
Main field of study	Management, General Track
Year	2018
Academic Advisor's Name	Associate professor, Andrey V. Zyatchin
Description of the goal, tasks, and main results	**Research goal:** to enhance existing method of operations strategy building under demand uncertainty through optimizing the production planning and decision making within accurate response strategy and estimate the efficiency of proposed enhancement on Sport Obermeyer case and Un.lock company case **Research tasks:** - Based on the review of academic literature specify an appropriate method of the operations strategy creation; - Propose enhancement of selected method of accurate response by optimizing production planning; - Apply modified method of operations strategy building to the case company and evaluate the impact. **Research results:** - Accurate response was chosen as reviewed operations strategy based on conducted literature review; - Production planning within accurate response was chosen to be the target operations strategy building method for enhancement proposal; - A method of production planning optimization utilizing linear programming, EVPI and newsvendor model was formulated; - The enhanced method was applied to case companies Sport Obermeyer and Un.lock and the positive impact of proposed optimization was identified.
Keywords	Supply Chain, Operations Strategy, Demand Uncertainty, Accurate Response, Production Planning, EVPI, Linear Programming, Newsvendor Model.

Table of Contents

Introduction

Most of the businesses in the world exist in an environment of uncertain demand and a lot of them are seeking a way to cope with it. One of the opportunities available to the companies is to adopt an operations strategy that will positively impact both market competitiveness and resource usage and mitigate the impact of the uncertain demand.

The interest of the firms towards operations strategies rises but the academic studies rarely provide frameworks for the operations strategy building process and we are striving to aid this cause by the current research.

The subject matter of the study can be defined as peculiarities of operations strategy building process under uncertainty of demand and assessment of potential for its improvement within a selected operations strategy, specifically production planning within accurate response strategy. The companies Sport Obermeyer and Un.lock are successively considered as the object of the study. The choice of Sport Obermeyer as the case company is justified by its renown and demonstrativeness and Un.lock was chosen to demonstrate proposed model transferability and adaptiveness.

The goal of the research conducted in this master thesis can be defined as the following:

To enhance existing method of operations strategy building under demand uncertainty through optimizing the production planning and decision making within accurate response strategy and estimate the efficiency of proposed enhancement on:

- Sport Obermeyer case
- Un.lock company case

This goal is achieved through consecutive completion of three objectives:

- Based on the review of academic literature specify an appropriate method of the operations strategy creation
- Propose enhancement for selected method of accurate response by optimizing production planning
- Apply modified method of operations strategy building to the case company and evaluate the impact

These three objectives establish the basic structure of the current master thesis. It consists of introduction, three chapters, each developing one of the research objectives, conclusion, list of references and appendices. The goal the first chapter is to justify the relevance of the topic chosen by providing a theoretical overview, to identify and state the research gap and the research objectives based on the conducted academic literature review analysis of operations strategy creation and implication. Main structural parts of the chapter are review and definition of the concept of operations strategy, followed by an investigation of approaches to operations strategy creation and their benefits and barriers and concluded with an evaluation of operations strategy peculiarities under demand uncertainty resulting in selection of an operation strategy to be reviewed and formulation of the research gap.

The second chapter is devoted to description of the methodology that was used for sequential mixed research method used in the thesis. Methods were selected according to the peculiarities of the researched subject. It consists of research design statement which is followed by formulation of the production process model. Then a production plan optimization aiming to raise the expected profit is proposed. Lastly, the required data collection method is described.

The third chapter is devoted to the demonstration of the applicability of the conducted empirical studies and created production planning optimizations and results one can expect from their application. The chapter is divided into two parts describing two chosen cases. In each case, data collection process is described, and choice of operations strategy is justified. Then collected data is applied to the proposed model and the results are interpreted in regard to theoretical relevance and practical applicability.

This paper utilizes both secondary and primary data. Secondary data is acquired through analysis of the academic literature regarding operations strategy and the peculiarities of its creation in the stated environment. All the research papers cited were accessed through academic databases such as EBSCO, Elsevier, ScienceDirect, and Emerald. The primary data represented by an expert interview with founder of Un.lock and collected demand prediction surveys.

CHAPTER 1. BUILDING OPERATIONS STRATEGY

The goal of this chapter is to justify the relevance of the topic chosen by providing a theoretical overview, to identify and state the research gap and the research objectives based on the conducted academic literature review analysis of operations strategy creation and implication. Main structural parts of the chapter are a review of the concept of operations strategy, followed by an investigation of approaches to operations strategy creation and their benefits and barriers and concluded with an evaluation of operations strategy peculiarities under demand uncertainty and approaches to enhance them.

1.1 Operations strategy concept

As the concept of operations strategy is relatively old (Skinner 1969) there are a number of definitions referring to it. In this research, we will be adverting to the most commonly cited in recent publications definition by Slack & Lewis (2002) which states: "Operations strategy is the total pattern of decisions that shape the long-term capabilities of any type of operation and their contribution to overall strategy, through the reconciliation of market requirements with operations resources".

Some researchers (Adamides 2015; Hill 2000) refer to the manufacturing strategy being the same as the operations strategy, but we will mostly use the term operations strategy in this thesis as it is universal and may be applied to a service providing company which has no manufacturing capabilities. That way manufacturing strategy may be viewed as a subset of operations strategy. But most of the researchers agree that development and implementation of any operations strategy must be conducted in agreement with corporate strategy alongside with marketing, financial, HR, and all other major strategies within the company. That way it will offer decision makers within the company a tool to design the processes and structure in alignment with the strategy.

During the last decade operations, strategy's significance increased due to greater access to process knowledge and a rising number of examples of successful implementation followed by strategic success.

There exists a literature review on the subject conjured by Andersen et al. (1989) in which the authors analyzed more than 80 articles on the subject of operations strategy from 1969 to 1989 and have come to the following conclusions: there exists a strategic view of operations contrary to the tactical view, that integration of business and operations strategic issues creates synergy, that there exist decision and policy areas in operations with strategic opportunities and lastly that there are examples of conceptual structures focused on operations strategy. This review brings a clear view of the subject 27 years ago, but the authors agree, that the existing terminology and concept of the time do not provide sufficient understanding of the theory. They state that more attention should be given to the content and process of operations strategy and the service operations strategy should be studied.

That literature review will be used as the core base of the research, but as it does not represent the current situation we will further analyze a number of concurrent research papers on operations strategy creation. We will base this theoretical overview on three main aspects of which exist among all the literature on the subject:

- There is no unified method of forming an operations strategy
- The number of publications on operation strategy largely exceeds those on processes and service
- Operations strategy formed in accordance with the corporate strategy amplifies organization performance

As the methods used by companies to create an operations strategy differ among the researchers and we stated the absence of the unified method of creating one that is superior to the others we need to analyze all the possible methods and processes of operation strategy creation. The genesis of the most common approaches can be found in Figure 1, but in this overview, we will focus more on the properties of these approaches

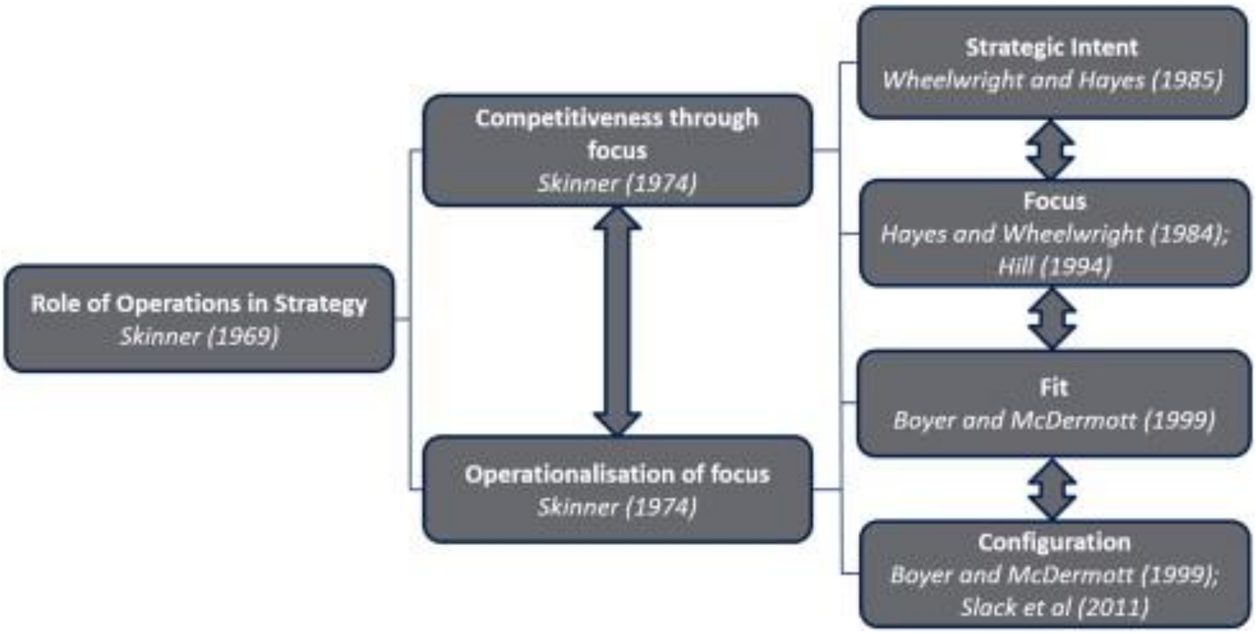

Figure 1. Evolution of OS (Maylor et al., 2015).

There also exists a number of strategy substitutes among which we can name Total Quality Management, Six Sigma, Lean and Business process re-engineering. Even though all of them are used on the level operations they are not operations strategies, and that way are not viewed in this research.

1.2 Approaches to operations strategy creation

Most studies view two traditional paradigms of formation of operations strategy. First one is as old as the concept of operations strategy and was introduced by Skinner (1969) when it is should be created by the top management. Skinner stated that operations (or as he stated manufacturing) strategy must support corporate strategy. The second approach is based on the decisions made on the process levels across all the company that form the operations strategy. First one is called top-down approach and has been viewed by the researchers significantly more than bottom-up approach. But the second one has its own area of application which includes situations of absence of formulated corporate strategy (Slack and Lewis 2002).

Top-down approach views the processes at their macro level as the planned coordination of intentions and actions from upper-level management to achieve specific outcomes and goals imposed by a central authority (Kim and Arnold 1996). In this kind of approach top-management of the company defines and sets strategic goals and then conjures a process flow for them to be implemented. Those processes not surely bring the company to the intended point and the based on the outcome are subjected to adjustments and rethinking. This approach may create mismatches with other strategies existing in the company such as marketing strategy and may encounter lack of support from the employees.

The bottom-up approach in contrary bases on the micro-level. It features defining constellations of processes that occur in the organization and lead to realized outcomes. In this situation, process-level management is encouraged to contribute to strategic goals of the company by implementing initiatives on their level of decision making. Slack and Lewis (2011) referred to this approach as "shaping objectives and action, at least partly by the knowledge it gains from day-to-day activities". In the research done by Rytter, Boer, & Koch (2007) this approach is used in practice to show its effectiveness in the condition of the collaboration of all the stakeholders of the company. The bottom-up approach may freely be used by any smaller company to maximize the effectiveness of their operations and bring the company to a new strategic level.

There also exists a third method studied by Kim, Sting, and Loch (2014) which implies integration of bottom-up and top-down approaches. Their study features internal processes of 52 bottom-up and 59 top-down action plans built on Kim and Arnold (1996) framework. They propose a model of correlation of top-down planning and bottom-up learning and state that centralized/decentralized organizational structure is a contingency factor for their balance with decentralized organizations being more prone to the bottom-up approach due to more trust in employees on the process levels and centralized organizations keen to control their processes from the top-management level. Overall, they state that both approaches complement each other in the real creation of an operations strategy. This kind of approach was firstly introduced by Barnes (2001) and had created a special area of interest but still has not a lot of research supporting its effectiveness, while at the same time this model may have the largest potential for future application.

In accordance with the trend of learning organization principle in processes, a lot of the more recent studies are focusing on top-down approach from the position of "formulate then implement". Nielsen-Englyst (2003) has conducted a research featuring seven-year case study consisted of four overlapping and iterative phases of learning, reviewing, aligning, and redirecting to support the claim of the continuous operations strategy review. It was based on the studies of Platts, Mills, Neely, Gregory, and Richards (1996) who were first to claim that there should be drawn more attention to organization and execution of the process in opposition to the logic of the approach. In this case, management was encouraged to delegate part of the strategy and mission processes to the employees. And, as a lot of traditional centralized and strictly structured company seek ways to morph into more flexible state in the time of crisis, this kind of approach to operations strategy as a continuous process may become a suitable solution to them, as it will continuously improve their processes and keep the company flexible, if successfully implemented and supported.

In publications on operations strategy exists a distinction between content-based and process-based approaches. The content approaches were studied by Rytter et al. (2007) who links operations with the creation of competitive advantage. This interaction can be done by introducing a norm protocol in the process of creation of operations strategy. In opposition, process approach concentrates on formulating and implementing an operations strategy. The currents position of the literature on the subject is that content-based approach vastly outnumbers process-based. Dangayach and Deshmukh (2001) have conducted a research concerning this problem and found that only 23 out of 260 viewed papers were dedicated to the process issues (which is less than 9%). Later the same issue was brought up by Boyer et al. (2005) who examined the contents of Production and Operations Management Journal on the subject of operations strategy and found eight articles that were process-based out of 31 articles on the subject. Those results bring up the need to analyze and compare process and content approaches to amend this type of misbalance, as clear view on the process of creation of operations strategy would be viable in the situation of the global economic crises.

If we assume the supporting aspect of the operations strategy towards corporate strategy in decision making in the fields of developing the formal structure, infrastructure, and capabilities in the plane of competitiveness, then we can say that the content-focused approach would address strategic decision of the infrastructure (including HR, OD, IT and management) and structure (process, technology, and manufacturing) that would result in reaching goals set to the market position (cost, quality, etc.) (Garrido, Martín-Peña, and García-Muiña 2007). In the literature, content is characterized as decision making in process and infrastructure, and we will address a concept by Voss (2005) who proposed three different paradigms of choice and content:

- competing through manufacturing
- strategic choices
- best practices

This concept of three paradigms was supported by Garrido et al. (2007) with the remark of none of those paradigms alone provide an explanation for the process of operations strategy creation. And we will now closer view each of these three paradigms one by one.

Skinner (1969) is considered not only the founder of the operations strategy but also the creator of the competing through manufacturing approach, as he was first to observe the rising importance of manufacturing beyond the supply of finished goods. This concept was later formalized by Wheelwright and Hayes (1984) who have discovered a direct correlation between competitive power and manufacturing capabilities in the production industry. It implies that companies need to coordinate their capabilities with both marketing and corporate strategies, demands of the market and key success factors (Voss 2005). The correlation of competitive advantage and operations strategy is a trend in current researches. Most of the companies that resort to competing through manufacturing approach tend to use the bottom-up approach on the creation of the corporate strategy, so all the levels of the organization would be able to share a common vision and be able to focus on the crated operations strategy.

In order to view the competitive position of the company we need to introduce competitive priorities which were first stated by Wheelwright and Hayes (1984) and later developed by Koste & Malhotra (1999):

- cost
- quality
- delivery dependability
- delivery speed
- flexibility

Those five priorities should be considered closely in the process of creation and application of the operations strategy as they represent corporate strategy focuses. Those five priorities have become key factors for the company's competitive position. Figure 2 represents their correlation with operations strategy.

In some sources (Slack 2002) this paradigm counteracted to market requirements as the organization should still satisfy the needs of the market and that way align their operations strategy with it.

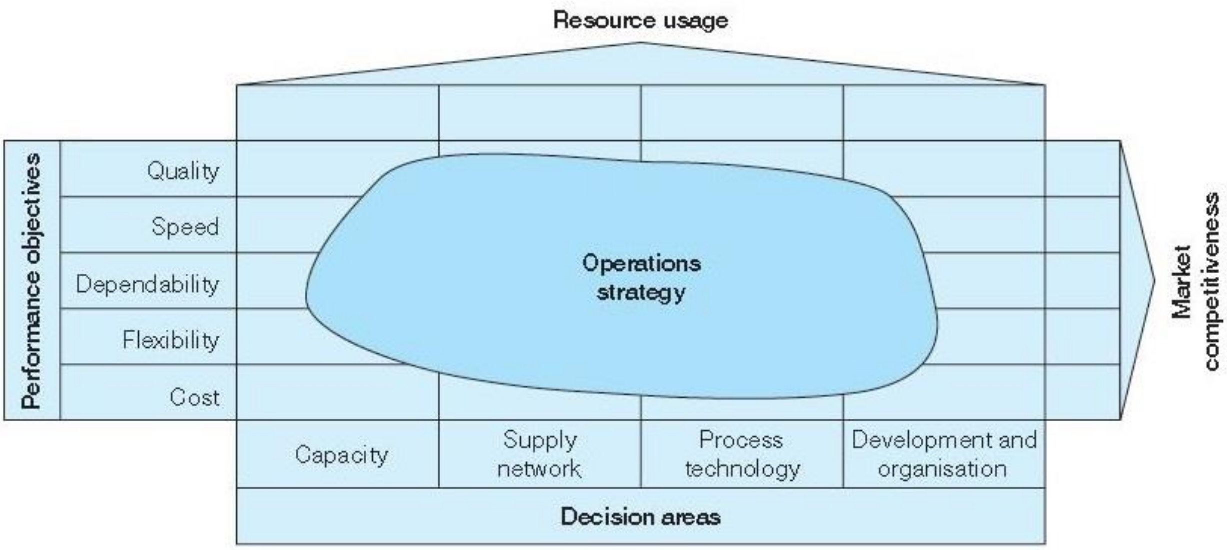

Figure 2. Operations Strategy matrix (Slack 2002).

As those kinds of priorities are vital for defining company's market competitiveness we can refer to researching company and clients' views on those priorities and their correlation as it is viewed in Figure 3

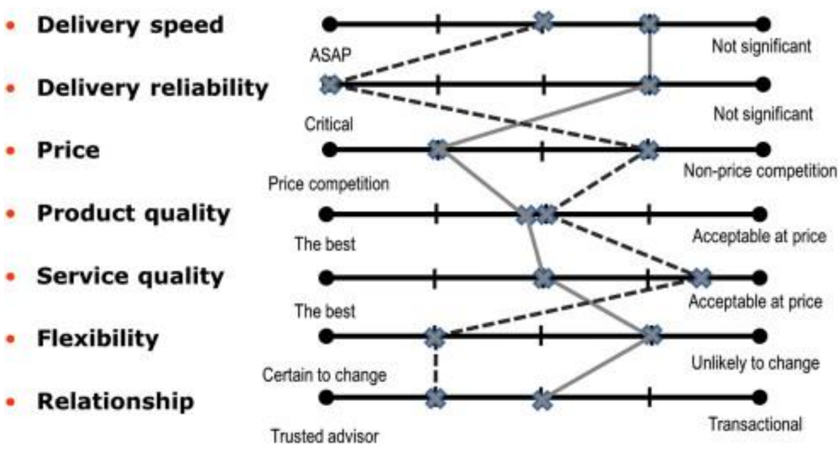

Figure 3. Competitive objectives as delivered by the provider and required by the client (Maylor et al. 2015).

The second paradigm which is strategic choices can be viewed concerning only the fields of process and infrastructure. This paradigm is applied using a situational approach as the strategic choices are made in accordance with the situation and environment concerning the company. The situational factor associated with this paradigm made researchers refer to strategic choices as the strongest strategy approach as it is providing the firms the ability to adjust operations strategy with the market situation. But this paradigm applies a set of requirements to the structure and infrastructure of the organization as it should have the flexibility to adapt to any new strategic choice that has led to the reformation of operations strategy. Operation strategy, in that case, should be exploiting the capabilities of operations resources of the organization.

The third and the last viewed paradigm of best practices is a relatively new approach that has been inducted by the main factors discussed in the literature. The first factor was the western world acknowledgment of the major success of the Japanese manufacturing industry, which they later attempted to replicate. The second factor is the spreading of businesses that are already implementing operational strategies and creation of various awards for best practices. The third was the increasing number of researches in the field of operations strategy dedicated to manufacturing technologies and processes like Just-In-Time. Research of Moran & Meso (2008) has proven that companies properly implementing best practice approach regularly exceed standards of operating performance. On the other hand, this approach was also proven to be harmful to the organizations which implement best practices improperly as it may lead major failures for any practice implemented.

Those three paradigms have been thoroughly investigated in a lot of researches and proved to be vital for the content approach to the operations strategy. Most of these researches recognize the role of the content approach in the success of business while paying close to none attention to the prosses of operations strategy development. The last two economic crises raised the need to adapt to changing environment who in their turn have raised the problem of lack of attention to the operation strategy development.

The answer to this call may be found in the process approach to operations strategy which focuses on its creation, development, and adaptation (Dangayach and Deshmukh 2001). It was firstly introduced by Hill (1989) a lot later than fist content approaches, where he introduced a step-by-step procedure of creation of operations strategy and thus founding the process approach. It was later expanded by Platts (1993) who offered a three-stage approach based on an audit. Those stages included:

- creation of the process
- testing on a limited number of organizations and adjustments
- investigation of opportunities for wide application

The further development of the process approach applied it to a learning organization in selection and evaluation of the processes (Mohanty and Deshmukh 1999). And focused on the usage of technology on the process level as it was stated (Orlikowski and Scott 2008) to underdeveloped compared to the rising usage of technology. Still, this approach can be called underdeveloped, but the trend in the researches is facing towards it and more researchers seek to understand the processes under the creation of the operations strategy that is highly applicable to the real business problems.

None of these two approaches can exist by itself and the real question that should be investigated regarding them is how to balance content and process, as both of them would maintain their relevance and be attractive for researchers. In order to answer it, Papadopoulos, Randor, & Merali (2011) have attempted to apply social practice and actor-network theories in order to understand the thinking process of managers responsible for operations strategy creation. They have succeeded in their research and with it induced a growth in the process-based researches on operations strategy. That addition of an individual human element to the theory creates an incentive to maintain the balance on the process and content as the operation strategy is still created at the level of the decision and process makers and should still be applicable and teachable to them.

Overall view on the operations strategy as a process in an organization can be found in Figure 4.

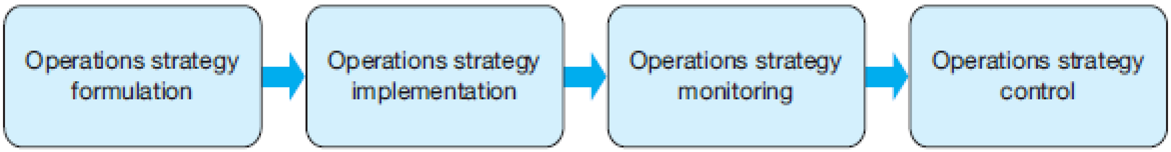

Figure 4. Stages of Operations Strategy (Slack 2002).

1.3 Benefits and barriers in operations strategy

After addressing the approaches to the creation of the corporate strategy we will continue with the justification of synergy created by the alignment of operations strategy and corporate strategy. As most of the concepts of operations strategy, it was introduced by Skinner (1969) who stated it to be an issue for further research. But it was out of the focus of the researchers for a significant amount of time. Mohanty & Deshmukh (1999) in their research stated that corporate strategy should be supported by operations strategy by the means of focus on the added value which is needed by consumers, markets or environment. This synergy is stated to be the most viable part of operations in a company and most recent researches (Adamides 2015) highlight the benefits that a company can achieve by making their strategies coordinated and aligned together.

The barriers that prevent this kind of alignment should be the main target for management to address in the situation of change (Krause, Youndahl, and Ramaswamy 2014).

The classic literature on operations strategy has been focusing on the standard manufacturing operations much more than on the constricts that can be induced by a faulty operations strategy to the competitive position of the company. (Maylor et al. 2015). Companies may have a constant awareness of their operational environment by focusing on the strategic choices that have an impact on the alignment of the organizational strategy and real processes and operations. In their research Maylor et al. (2015) have proven that concentrating operations and processes on specific goals is essential in creating stability in the company which can be later used as a base for alignment of operations strategy and communicating it to the whole company. It is also supported by Krause et al. (2014) claiming that stability and communication are vital parts before a company could integrate operations and corporate strategies.

In their work Krause et al. (2014) also have provided a number of organizations that can be used as an example of companies that have used their operational excellence to create sustainable competitive advantages such as Wal-Mart or P&G. This kind of operational and process leadership was confirmed by several qualitative researches (Kiridena et al. 2009) to benefit competitiveness and reduce costs, but the real question that arises is why some companies do not make align their operations strategy with corporate strategy despite the advantages. In his later studies, Skinner (2007) have noticed that 95% of the organizations he has studied are facing problems in bringing together the competitive strategy with operations strategies. Krause et al. (2014) explain that this kind of issue may occur not because of lack of effort but because of miscommunication and lack of understanding of the integration procedure.

Slack (2005) claims that operations strategy is not yet at its full potential despite the rising interest from the business and their concerns about its effect. He also states the major part of the available literature has a biased view while process and practice are irrelevant. In addition to that low recognition of the subject may be caused by a disconnection between the operations viewed in theory and their practical counterparts. The next probable cause is confusion between two terms operations strategy and manufacturing strategy which we discussed in the beginning of the chapter. This argument continues until now, but in this thesis, we have already made our statement on it. Krause et al. (2014) have also stated lack of understanding among the businesses of those terms.

As we have already stated, there exists a trend among businesses towards becoming more decentralized and that way creating an opportunity for a bottom-up approach in operations strategy creation. The same trend offers companies an opportunity to reform their culture into a collaborative movement towards the strategic goals through focusing on processes. Alignment of the operations strategy with the corporate strategy, in that case, is done by communicating this approach throughout the whole company process-level until this alignment becomes a part of route process Adamides (2015). This type of strategy adds emotional commitment of the workers to the operational success as they feel direct responsibility. Peer pressure accompanied by the culture help and empower employee collaboration and personal accountability for the processes. This statement can be supported by research of Gomez (2010) who claims that workers involved in the process of operations strategy development and feel the impact they make most likely will develop a personal commitment to the process and responsibility that will result in the overall company success.

One statement that can be seen in any scientific research on the subject is that it is able to bring success to businesses. Studies recognize the correlation between operations strategy and operation success and directly connect operations strategy with overall company performance. A well-made operations strategy can play a key role in companies strive of obtaining and sustaining of a competitive advantage. A company that can successfully align their operations and corporate strategy is confirmed by research to have increased chances of becoming competitively successful compared to those who fail to achieve such an alignment.

In questions of operations strategy creation this theoretical overview we have examined more than 30 different articles and studies from the introduction of the operations strategy to the most current ones. However, we should state that there exists a lack of concurrent research, especially in the last three years. They have all supported the initial proposition of the overview and the main three aspects that were stated. Next, we will discuss demand uncertainty's influence on the operations strategy creation.

1.4 Using operations strategy to mitigate demand uncertainty and research gap

Since unknown demand is the environment most of the companies exist in, it has a lot of impact on their behavior and their operations strategy creation in particular. They incorporate operations strategy that will bring tools to mitigate its effect.

Uncertain demand impacts both performance objectives and decision areas of the company. Decision areas include capacity, supply network, process technology, development, and organization. All of them may be used in effort to counter the effects of the demand variability resulting in different sub-strategies or series of strategic decisions.

Regarding performance objectives that lead to market competitiveness, speed and flexibility are directly connected to the demand uncertainty issues and will be discussed further. Influence of the cost and quality on the uncertainty of demand is an issue for further studies as those attributes may lower or elevate uncertainty in different situations. Last performance objective, dependability is the consequence of the company's efforts to cope with uncertainty and may be used to measure its effectiveness.

Based on the academic literature reviewed we can highlight three major solutions within operations strategy building that are used in the uncertain demand environment: Quick response, Accurate response, and Postponement. Each of those solutions we will further refer to as a strategy or sub-strategy, but at the same time knowing that each of those, if used, should be an integral part of company's operations strategy. These three strategies use different decision areas and different approaches to counter the uncertain demand.

Quick response (QR) implies leveraging the whole supply chain in order to shorten lead times and that way respond to the market demand fluctuations fast. This idea came from the concept of time-based competition and was first formulated by Rajan Suri in the late 80's. QR is widely discussed in the academic literature as EBSCO database contains 650 articles on this subject in regard to supply chain management developing most of the aspects of the subject. Companies utilizing QR focus on their supply network and process technology as their main decision areas and make speed their priority performance objective. This type of strategy may be used by any type of manufacturing companies and is frequently used in real business cases.

One if the most modern trends in quick response strategy is quick response forecasting concept proposed by Larry Lapide (2018) that implies data collection from the most dynamic sources such as social networks to distinguish trends in consumer behavior and react to them accordingly. This system works at the intersection of big data and operations strategy and is close to accurate response as it focuses on production planning and its rectification.

The postponement is an operational solution that is most used in made to order (MTO) type of products that implies modifications of supply chain to postpone customization of a product and that way be able to react to market demand in a fast way. EBSCO database contains 854 articles on this subject in regard to supply chain management also widely developing its peculiarities. This operations strategy type mostly affects process technology as this is the main instrument of transformation of the production process to be able to postpone customization of the MTO products resulting in reaching a performance objective of flexibility. This type of strategy is used by companies in the fashion industry to postpone customization of apparel.

Accurate response type of operations strategy focuses on meeting the demand in its uncertainty by adapting the supply chain and the selling process into production planning process to be able to rectify the production plan at multiple points and accurately meet the demand. It was introduced by the Harvard Business School case "Sport Obermeyer Ltd" (Hammond and Raman 2006) which featured the named company as an example of existing enterprise already employing accurate response. Despite the fact, that accurate response is a strategy used in real business, EBSCO database contains only 19 articles on this subject in regard to supply chain management that makes it favorable for current research. This type of strategy is most appropriate for a two-stage production process that was described in the Sport Obermeyer case and implies opportunity to produce some products proactively before the realization of demand and some products reactively in pursuant to the demand. We will elaborate on this production model in the second chapter. Decision areas relevant to accurate response are development and organization, and capacity as they are used to reach flexibility performance objective.

Each of these strategies: QR, postponement or accurate response can be used separately or in combination with other operations strategy types, such as quick response by postponement proposed by Reimann (2012), as they use different decision areas.

As we have previously stated, accurate response is the least researched sub-strategy among quick response and postponement all of which are parts of the operations strategy building process. That is why for this thesis we will choose accurate response as the operations strategy we will review.

Building of an accurate response strategy consists of two major parts: a manufacturing model that allows for production plan rectifications at certain points and the production plan itself. We consider production planning the most crucial element of the operation strategy building process since it is based on meeting the demand through planning. That makes optimization of production planning a substantial enhancement of operations strategy creation within the accurate response.

From the review of academic literature, we may highlight four approaches to production planning optimization:

- Heuristic
- Linear programming
- Stochastic programming
- Robust optimization

Heuristic approach rarely can ensure optimality of the proposed production plan and we will further heuristic approach used by HBS for comparison of the results. Out of other approaches, only linear programming and stochastic programming be found in academic databases regarding the accurate response, each only once. Those researches are Reimann (2016) and Kouvelis, P. et.al. (2008) respectively.

That way the research gap addressed in this master thesis may be formulated lack of academic research on production planning and its optimization within accurate response operations strategy that is currently utilized by the businesses.

In this chapter, we discussed issues of operations strategy, its creation and its peculiarities under uncertainty of demand and formulated the research gap of the current thesis. We have identified three operations sub-strategies used in an environment of uncertain demand and have selected accurate response for further research. Within accurate response, we have selected production planning as part of operation strategy building method as a target for enhancement proposal.

Next chapter is dedicated to research design description, formulation of the production model reviewed, enhancement proposal and data collection.

CHAPTER 2. OPTIMIZING PRODUCTION PLAN IN ACCURATE RESPONSE

The goal of this chapter is to describe the methodology that was used for sequential mixed research method used in the thesis. Methods were selected according to the peculiarities of the researched subject. It consists of research design statement which is followed by formulation of the production process model. Then a production plan optimization aiming to raise the expected profit is proposed. Lastly, the required data collection method is described.

2.1 Research design

On the basis of the research gap in the academic studies in the field of operations strategy under uncertainty of demand we can formulate the goal of current master thesis as to enhance existing method of operations strategy building under demand uncertainty through optimizing the production planning and decision making within accurate response strategy and estimate the efficiency of proposed enhancement on:

- Sport Obermeyer case
- Un.lock company case

This goal is reached by consecutively completing three objectives which are:

- Based on the review of academic literature specify an appropriate method of the operations strategy creation
- Propose enhancement of selected method of accurate response by optimizing production planning
- Apply modified method of operations strategy building to the case company and evaluate the impact

In this master thesis, a sequential mixed method was applied. This method of research implies collection of both qualitative and quantitative data and its analysis within a single study. As the first type of data provides a basis for collection of the second type, the research may be characterized as sequential. This research can be classified as two-phase exploratory as it may be dissected into two general phases qualitative followed by quantitative. This design justified by the need of a model development that will comply with the requirements of the studied case and be theoretically justified since we deal with uncertainty.

The qualitative part of the thesis consists of an analysis of the approaches to operations strategy creation under demand uncertainty and justification of selection of accurate response as the chosen strategy basing on the conducted expert interview and case analysis followed by the model proposition. This part is followed by the quantitative phase which provides application of the proposed model starting with the collection of data using a survey and its analysis and application to the operation strategy building method through the proposed production planning optimization. All these phases are elaborated in the thesis. Application of the proposed optimization is described in the third chapter followed by results discussion.

2.2 Production model formulation

Based on the conducted interview and literature review we will use two-stage production concept in our model as it may be fully utilized in the accurate response operations strategy and is appropriate to the cases studied.

Two-stage production implies that there is an opportunity to produce goods before the demand occurs e.g. before the official launch of the product. This model type is best applicable in cases of fashion and hi-tech innovative products. We will refer to production that occurs before the demand as proactive, and as reactive to the production during the time of demand. Capacities of both of these production types depend heavily on production and selling cycles. For innovative product, it may mean introduction and application of a new technology making previous products out of date such as high-tech flagship phones that are presented every year. For fashion, it mostly depends on fashion seasons.

Reactive production is beneficial as it is done in accordance with the occurring demand, but it is limited by manufacturing capability and selling season length. That way a company may lose part of the profit because of inability to satisfy all the demand and thus result in a low service level and hurt the brand and business reputation. Proactive production may mitigate the risk of understocking the product, but at the same time brings a risk of overstocking it.

Usage of the two-stage production can help a company adapt accurate response strategy without extra investment into capabilities that are required by the QR or changing the production process that is required to utilize postponement. The downside of this production type is that company's clients will face drastically different lead times when purchasing products manufactured proactively and reactively.

Thus, in the model, we will consider a situation where the company has chosen to apply two-stage production in order to build an accurate response operations strategy. The company has a set of products that it is going to offer to the market during next selling period. Each product has manufacturing costs associated with it, a price that is set by the company and a salvage value which the product can be salvaged for at the end of the selling season. The products are considered fully independent and have no influence on demand for each other. The company has limited manufacturing capabilities both proactive and reactive.

Graphical representation of two-stage manufacturing model we use for our calculations may be seen in figure 5.

Figure 5. Two-stage production model.

2.3 Production planning optimization proposal

In order to propose an optimization for production planning we need to introduce two concepts used: newsvendor model and expected value of perfect information.

The newsvendor model is the classical mathematical model used for capacity management of short life cycle products such as fashion or high-tech. The core concept of the model to acquire capacity while anticipating unknown demand by balancing the expected cost of under-ordering versus the cost of over ordering. This is a reliable solution for the one-stage production, but it may not be utilized to full extent through the production model we stated earlier, so we need to incorporate additional conditions.

The expected value of perfect information (EVPI) is the price that one would be willing to pay in order to gain access to perfect information (Hubbard 2007). We will utilize this value in our calculations as the monetary value of risk that we take by producing a product without the information on the demand.

We propose to utilize the concept of expected value of perfect information (EVPI) and linear programming that is easily accessible in order to adapt newsvendor model to a two-stage production planning process that will lead to a rise of expected profit and that way enhancing building of an accurate response operations strategy.

To optimize the production plan, we propose to use the simplex algorithm. Simplex algorithm guaranties robust optimal solution for reviewed function within a convex function domain. This is one of the popular algorithms used in linear programming and was firstly proposed by George Danzig, who alongside with Leonid Kantoroich founded the linear programming (Gass 2011).

Variables denotation:

P_i Selling price of product *i*

C_i Production cost of product *i*

SV_i Salvage value of product *i*

μ_i Demand mean for product *i*

σ_i Standard deviation for demand for product *i*

VP Proactive production capabilities

VR Reactive manufacturing capabilities

For the sake of utilizing the newsvendor model, we assume $SV_i<C_i$ as otherwise, it will lead to the problem of utilizing capacity rather than production planning.

The newsvendor model implies that all the demand occurs after the process of production or supply is finished. The optimal order quantity in this model is computed using overage C_o and underage C_{ui} costs for the product and reverse demand distribution function. With $C_{oi}=C_i-SV_i$ and $C_{ui}=P_i-C_i$ optimal order quantile $z_i{}'$ is calculated using the formula (1).

$$z_i{}' = \frac{C_{ui}}{C_{oi} + C_{ui}} \tag{1}$$

This is the optimal integral distribution probability that we may turn into order quantity using reverse demand distribution function. In MS Excel it is calculated as *z=NORMSINV(z')*. That way we may calculate optimal order quantity *Q* as (2).

$$Opt.Q_i = \sigma_i * z_i + \mu_i \tag{2}$$

Profit for the newsvendor model is calculated using standard loss function which is defined as (3) (Berger 1985), where *f(t)* is the standardized normal density and denotes expected lost sales. In excel it is calculated as L*(z)=NORMDIST(z,0,1,0)-z*(1- NORMDIST (z,0,1,1))*. The amount of expected lost sales then calculated as (4).

$$L(z) = \int_z^{\infty} (t - z) f(t) dt \tag{3}$$

$$Expected\ Lost\ Sales_i = \ \sigma_i * L(z_i) \tag{4}$$

Using expected lost sales, we calculate expected sales as:

$$Expected\ Sales_i = \ \mu_i - Expected\ Lost\ Sales_i \tag{5}$$

Which leads us to leftover inventory with the order quantity of Q

$$Expected\ Leftover\ Inventory_i = Q_i - Expected\ Sales_i \tag{6}$$

Resulting in expected proactive production profit function of π_i^P of product *i* calculated with (7).

$$\pi_i^P = Expected\ Sales_i * P_i - Expected\ Leftover\ Inventory_i * C_{oi}$$
$$= \left(\mu_i - \sigma_i * L(z_i)\right) * (P_i - C_i) - \left(Q_i - \mu_i + \sigma_i * L(z_i)\right)(C_i - SV_i) \quad (7)$$

Using this profit function, we may calculate expected proactive profit π_i^P for each product *i*, assuming that it was fully produced in the first stage. If we choose to manufacture a product reactively then our expected profit can be calculated using (8) where *E(D)* is the expected demand for the product resulting in (9).

$$\pi_i^R = E(D_i) * (P_i - C_i) \quad (8)$$

$$\pi_i^R = \mu_i * (P_i - C_i) \quad (9)$$

That way we may view π_i^R as profit that we may expect having perfect information regarding the demand and π_i^P as optimal profit with no information on demand for product *i* bringing us to EVPI of the product which is calculated as:

$$EVPI_i = \pi_i^R - \pi_i^P \quad (10)$$

EVPI represents the monetary value of risk we take by producing a product proactively instead of reactively. To minimize the value of the risk we take we may assign risk coefficient *r* to every product calculated with (11), sort the products in coefficient order and chose products with lower coefficients to be produced proactively and the ones will higher coefficients to be produced reactively. At the same time, we should consider two limitations (12) and (13).

$$r_i = \frac{EVPI_i}{Q\ opt._i} \quad (11)$$

$$\sum_{i \in proactive} Q\ opt_i \leq VP_i \quad (12)$$

$$\sum_{i \in reactive} \mu_i \leq VR_i \quad (13)$$

This is a heuristic "greedy" algorithm that was used in the solution for the production planning problem in HBS case. It leads to a viable production planning solution and selection of products to be produced in each of the stages of production, but it may not be optimal.

To achieve optimal production plan, when selecting a product to be fully produced in one of the phases, we need to create a set of binary variables x_i representing the intent of producing the product reactively and create a simplex algorithm problem to maximize the multiplication of the binary set on the corresponding EVPI value for each product type within constrains of manufacturing capabilities. The same way we deal with proactive production optimization using a set of binary variables x_j. Since the model is linear and the variables set is convex this solution is optimal, and we have achieved maximum possible value of the risk we did not take using EVPI. The target functions may be formulated using as (14) and (16) and the restrictions used as (15) and (17) respectively.

$$Max\left(\sum_{i\in reactive} x_i * EVPI_i\right) \tag{14}$$

$$\sum_{i\in reactive} x_i * \mu_i \leq Reacive\ Capasity \tag{15}$$

$$Min\left(\sum_{j\in proactive} x_j * EVPI_j\right) \tag{16}$$

$$\sum_{j\in reactive} x_j * Q_j \leq Proactive\ Capasity \tag{17}$$

To ensure optimal values of risk taken we may employ linear programming. Easiest obtainable tool to do so is Microsoft Excel solver add-in which is a free software able not only to optimize linear systems on convex sets of variables but also GRG nonlinear optimization and evolutionary solving method. It has a limit of 200 variables and may not be suitable for large nomenclature manufacturers. In those cases, we would propose to use MATLAB or other specialized software solutions. In MS Excel the multiplication of the binary set on the corresponding EVPI value for each product type may be represented using SUMPRODUCT function.

This optimization may be directly programmed into solver add-in and conducted using two linear optimizations for each production stage. For proactive production, we will optimize (16) with a restriction on manufacturing capabilities of (17). For reactive production, we optimize (14) with a restriction of (15).

Since this model is based on the principle, that we may produce the product only proactively or reactively in its full quantity, this may lead to an inability to use it in some cases e.g. with low manufacturing capabilities. We may cope with it by proposing linear optimization on the level of the order quantities instead of product selection level.

For that, we create two sets of non-negative integer variables x_j denoting proactive and x_i denoting reactive production quantities for each product type. EVPI in this case is employed using risk coefficient r_i calculated with (11). The optimization model in this case may be formulated with (18) as target functions for first iteration with (19) and (20) used as restrictions resulting in reactive production plan and (21) as target function with (22) and (23) used as restrictions resulting in proactive production plan.

$$Max\left(\sum_{i\in reactive} x_i * r_i\right) \tag{18}$$

$$\sum_{i\in reactive} x_i \leq Reacive\ Capasity \tag{19}$$

$$x_i \leq \mu_i \tag{20}$$

$$Min\left(\sum_{j\in proactive} x_j * r_i\right) \tag{21}$$

$$\sum_{j\in reactive} x_j \geq Proactive\ Capasity \tag{22}$$

$$x_j \leq Q_j \tag{23}$$

This also may be directly programmed into solver add-in using two simplex algorithm linear optimizations for proactive and reactive production respectively resulting in optimized sets of production quantities for each product.

As we are using simplex method optimization it ensures optimal value for the target function within the set restrictions if the solution is achievable.

To evaluate the impact of the proposed optimizations we may calculate expected profits for each production plan using (7) for proactive production and (9) for reactive production and using the order quantities from the plans.

In order to apply the proposed optimization and evaluate the effect, we will need to obtain the data from the case companies.

2.4 Data obtaining

The proposed optimization needs to be applied to appropriate production model within accurate response operations strategy and thus needs qualitative data on the manufacturing process that may be obtained through documental analysis or expert interview.

Two main sets of quantitative data needed for the model are properties of demand and properties of the product cost structure and profits. The demand properties may be obtained by surveying the experts in the company on their predictions of the demand for each product and then test obtained data sets for normality and calculate mean and standard deviation. We expect the experts of the firm to have a wider knowledge of the company’s products, interest of the consumers and historical data. Profit and cost structure may be obtained either through documentary analysis or an expert interview.

Since we assume a normal distribution for our demand we will use Shapiro-Wilk test on the data sets we have, as it is considered to have the best power for a given significance.

In order to collect the data, we have conducted a documentary analysis of the Sport Obermeyer case published by Harvard Business School (Hammond and Raman 2006) from which we extracted data we used in chapter 3 and organized an expert interview with the founder of Un.lock. Within that interview, we have clarified company's production characteristics and found out that accurate response strategy with two-stage production planning can be applied to their case. This led to a need of collecting qualitative data on the product cost structure that was also inquired through an interview with the founder and a need for creation of a survey that was distributed among the employees engaged in the production and selling regarding the demand predictions for each type of product. Data obtained from the survey can be found in Appendix 1.

Next chapter is dedicated to application of proposed optimizations using the collected data.

CHAPTER 3. PRODUCTION PLAN OPTIMIZATION APPLICATION

This chapter is devoted to a demonstration of the applicability of the conducted empirical studies and created production planning optimizations and results one can expect from their application. The chapter is divided into two parts describing two chosen cases. In each case, data collection process is described, and choice of operations strategy is justified. Then collected data is applied to the proposed model and the results are interpreted in regard to theoretical relevance and practical applicability.

3.1 Sport Obermeyer case

Sport Obermeyer is an American sports apparel company founded in 1947 in Aspen, Colorado. This company is one of the trendsetters in accurate response operations strategy as it was utilizing two-stage production and multiple point production planning rectifications back in the early 90s. This company's experience was used by Harvard Business School which published a case study in 1994 that has been later reviewed in 2006 and is currently used in MBA programs concerning supply chain.

This case was chosen as it suits reviewed production model within accurate response strategy and its renown. Production process in the case can be divided into proactive and reactive stages.

From the case data, we can define production capabilities being $VP=VR=10000$. All other data retrieved from the case including product range, predictions of the demand mean and deviation for each product, profits and cost structure can be seen in Table 1.

Table 1. Obermeyer case initial data

Product #	1	2	3	4	5	6	7	8	9	10
Mean, μ	1017	1042	1358	2525	1100	2150	1113	4017	3296	2383
S.deviation, σ	388	646	496	680	762	807	1048	1113	2084	1394
Price	110	99	80	90	123	173	133	73	93	148
Cost	83,6	75,24	60,8	68,4	93,48	131,48	101,08	55,48	70,68	112,48
Salvage value	74,8	67,32	54,4	61,2	83,64	117,64	90,44	49,64	63,24	100,64

Using this data, we calculate expected reactive profit using (9), optimal expected proactive profit using newsvendor model formulated by (7) and EVPI for each product with (10) all of which were described within optimization proposal. The results of the conducted calculations for each product are represented in the Table 2.

Table 2. Obermeyer case expected profits and EVPI data

Product #	1	2	3	4	5	6	7	8	9	10
Optimal proactive profit	22509	18255	22039	48317	22941	75071	21353	62116	53858	63665
Reactive profit	26849	24758	26074	54540	32472	89268	3553	70378	73567	84644
EVPI	4340	6503	4035	6223	9531	14197	14174	8262	19709	20980

We use data from Tables 1 and 2 in the heuristic approach discussed in the HBS case solution and was described earlier. This approach results in a production plan that may be seen in Table 3 representing quantities of each product to be produced in each manufacturing stage.

Table 3. Obermeyer heuristic approach production data

Product #	1	2	3	4	5	6	7	8	9	10
Reactive production	0	1042	0	0	1100	2150	1113	0	0	2383
Proactive production	0	0	1693	2984	0	0	0	4768	0	0

We can evaluate this plan by calculating the expected profit using (7) for products produced proactively and (9) for reactive totaling in $399140. Since it a heuristic approach and it does not fully utilize the manufacturing capabilities, we may enhance this situation by employing linear programming that leads. Applying two simplex algorithm optimizations using (14-17) results in a production plan described in Table 4.

Table 4. Obermeyer linear programming optimized by product type production data

Product #	1	2	3	4	5	6	7	8	9	10
Reactive production	0	1042	0	0	0	2150	1113	0	3296	2383
Proactive production	0	0	1693	2984	0	0	0	4768	0	0

This manufacturing set results in an expected profit of $440235, which is already significantly higher than the previous result, but we still don’t utilize the production capacity to its full extent and thus should apply optimization by product quantity. Using the simplex algorithm linear optimization as we discussed with (18-23), we get the production quantities for each product represented in Table 5.

Table 5. Obermeyer linear programming by product quantity production data

Product #	1	2	3	4	5	6	7	8	9	10
Reactive production	0	1042	0	0	1100	2150	1113	0	2212	2383
Proactive production	558	0	1692	2983	0	0	0	4767	0	0

This production composition results in an expected profit of $462449,7, which is significantly greater than the previous one and fully uses the manufacturing capabilities. This leads to the conclusion that using EVPI and linear programming has allowed us to increase the expected profit by almost 16% just within the confines of the accurate response strategy without changing the supply chain for the case of Obermeyer company. These results and managerial applications will be discussed further in the chapter.

3.2 Un.lock case

Un.lock is a high-tech startup founded in 2017 by a GSOM graduate Ilya Drozdov in Moscow. The company produces high-tech locks for standard doors and, at the time of creation of this thesis, is preparing to launch its first range of products.

During the interview with the founder, we investigated company’s position toward coping with the uncertainty of demand and deduced that accurate response strategy is suitable for the company’s needs and capacities.

As the official launch of the first set of products is yet to come, the company has an opportunity to manufacture part of the products before the demand starts to occur, resulting in an opportunity to employ two-stage production and benefiting from accurate response strategy.

The company anticipates that the demand period of first product range will be limited by the introduction of the next generation and any produce unsold may be salvaged for parts to be reused.

Production plan needs to utilize the opportunity to produce up to 1500 units proactively and up to 2500 units reactively.

All the cost structure data was acquired from the interview with the company founder and the demand predictions acquired through survey were Shapiro-Wilk tested. The test has shown that all the data sets are normally distributed. All the collected data needed for the model can be seen in Table 6.

Table 6. Un.lock case initial data

Product	1	2	3	4	5	6
Mean, μ	840	780	490	540	480	710
Standard deviation, σ	684,1	722,5	414,4	307,0	356,4	548,2
W	0,827	0,831	0,810	0,901	0,950	0,962
Price	3000	5000	4000	4000	6000	4500
Cost	1500	1800	1300	1300	1800	1500
Salvage Value	900	900	900	900	900	900

As in the Obermeyer case we use this data to calculate expected reactive profit, optimal expected proactive profit using newsvendor model and EVPI for each product, the resulting values are represented by Table 7.

Table 7. Un.lock case expected profits and EVPI data

Product	1	2	3	4	5	6
Optimal proactive profit	7716845	1620019	1052626	1257711	1545006	1636933
Reactive profit	1260000	2496000	1323000	1458000	2016000	2130000
EVPI	488315	875981	270374	200289	470994	493067

Using the same heuristic approach, we compute a set of production quantities for each period denoted by Table 8 representing quantities of each product to be produced in each manufacturing stage..

Table 8. Un.lock case heuristic approach production data

Product	1	2	3	4	5	6
Reactive production	0	780	0	0	480	710
Proactive production	0	0	959	887	0	0

This production plan can be evaluated with the expected profit of 8952337₽. To optimize the production planning for the company we offer to employ linear programming. First, we use the optimization by the product type to be produced in one of the phases, that results in a production plan that is represented in Table 9.

Table 9. Un.lock case optimized by product type production data

Product	1	2	3	4	5	6
Reactive production	0	780	490	0	480	710
Proactive production	0	0	0	887	0	0

Expected profit for this production set can be calculated as 9222711₽. This production plan does not utilize the manufacturing capabilities to a full extent, so we apply linear optimization by product quantity with the resulting production quantities denoted by Table 10.

Table 10. Un.lock case optimized by product quantity production data

Product	1	2	3	4	5	6
Reactive production	530	780	0	0	480	710
Proactive production	0	0	613	887	0	0

With this production plan, the company does fully utilize manufacturing capabilities both proactive and reactive with the expected profit of 9624220₽. As in the first case we have achieved a significant rise in the expected profits utilizing the model. Next, we will analyze and discuss the received results.

3.3 Results interpretation and discussion

In the second chapter we have formulated a production model and tools for production plan creation and optimization within the accurate response strategy that employ linear programming, EVPI, and newsvendor model.

In this chapter, we have applied the heuristic approach and proposed production plan optimizations to the case companies. For the companies, we used the data retrieved from the documental analysis, expert interview, and expert survey. Using this data, we have computed three different sets of production quantities for each period and each company. For each of the three stets: heuristic, optimized by product type, and optimized by product quantity we have calculated expected profits with help of newsvendor model. Graphical comparison of the resulting expected profits may be seen in Figure 6.

By optimizing the production plan, we have achieved a 15% rise in the expected profits in Obermeyer case compared to heuristic approach and 8% rise in the expected profits in the case of Un.lock. This increase in the expected profits was achieved without any modification of the existing production process or the supply chain that makes it an appealing tool for the manufacturing level decision makers.

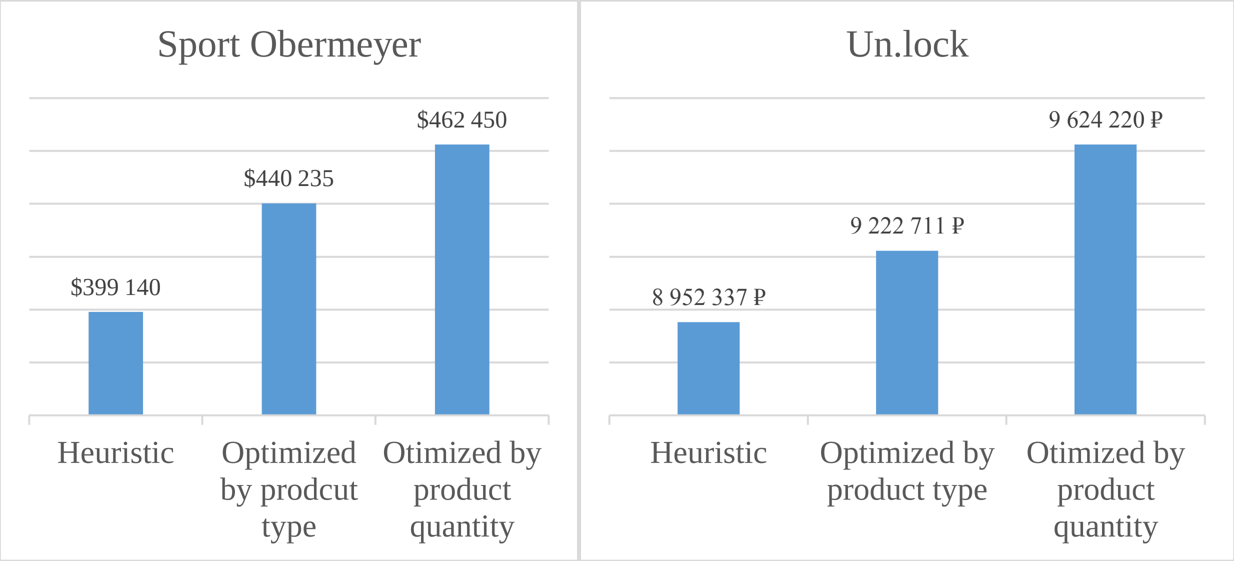

Figure 6. Expected profit of case companies comparison.

If the manufacturing model of a company already implies limited selling season and presence of proactive manufacturing capabilities production optimization tools can be applied and potential effect evaluated.

Proposed optimization tool is easily adaptable to any set of data regarding demand or product properties or production capabilities. All the optimizations were conducted using standard office software making them easily accessible.

Usage of the simplex algorithm ensures the robust optimality of the result within the stated model. And at the same time, it may be stated as a limitation, as its usage limits the optimized value to a linear function. Optimization through non-linearly calculated values such as order quantile may lead to production plans with potentially higher expected profits, but optimality of these solutions is not guaranteed on whole function domain. This should be used as a topic for future research. Another limitation is the usage of the demand prediction data obtained through the company’s experts. While we expect them to have a deep understanding of their product and their customers the data they provide may be reinforced by marketing research.

This makes production planning optimization through linear programming an accessible and adaptive tool for manufacturing level decision making that enhances the accurate response operations strategy building process.

Conclusions

In this thesis, we have conducted an academic literature review regarding operations strategy, its creation process and impact of the uncertainty of demand. We have identified three main sets of strategic decisions within operation strategy, which were quick response, postponement, and accurate response. Accurate response was selected for the review in the thesis. On that basis, we specified a method of operations strategy building appropriate for the studied cases being two-stage production planning within accurate response strategy.

Then, in the second chapter, we have proposed an enhancement of the specified strategy of accurate response through optimization of production planning that utilizes EVPI, newsvendor model, and linear programming which leads to optimal solutions within specified boundaries. We defined the dataset needed for this model and proposed ways to obtain it.

Lastly, we applied the developed method to the production planning process of case companies and evaluated the results through calculation of expected profits, which may be used by the decision makers to plan the production efficiently. The results obtained show a significant impact of the proposed enhancement on the expected profits.

That way we have completed the set objectives of the thesis to the full extent and reached the goal to enhance existing method of operations strategy building under demand uncertainty through optimizing the production planning and decision making within accurate response strategy and estimate the efficiency of proposed enhancement on two business cases.

Optimizing the production plan through linear programming was proven to raise the expected profit of the company for the reviewed selling season by a significant amount without affecting the production process or capacities.

The proposed production plan optimization is applicable to any business which operates in similar production cycles and easily approachable as it may be applied using standard software bringing it a wide potential for real-life business applications.

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Appendix 1. Expert survey of the demand forecasting data

Un.lock case

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5
Product 1	2000	200	600	600	800
Product 2	2000	200	300	800	600
Product 3	1200	150	250	450	400
Product 4	1000	250	350	400	700
Product 5	1000	100	200	500	600
Product 6	1500	100	300	750	900
Sum	8700	1000	2000	3500	4000

Sport Obermeyer case

	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Product 1	900	1000	900	1300	800	1200
Product 2	800	700	1000	1600	950	1200
Product 3	1200	1600	1500	1550	950	1350
Product 4	2500	1900	2700	2450	2800	2800
Product 5	800	900	1000	1100	950	1850
Product 6	2500	1900	1900	2800	1800	2000
Product 7	600	900	1000	1100	950	2125
Product 8	4600	4300	3900	4000	4300	300
Product 9	4400	3300	3500	1500	4200	2875
Product 10	1700	3500	2600	2600	2300	1600
Sum	20000	20000	20000	20000	20000	20000