

STRATEGO

Manufacturing strategies supporting competitiveness in
small and medium-sized manufacturing enterprises



A HANDBOOK

Kristina Säfsten, Mats Winroth, and Malin Löfving



STRATEGO Manufacturing strategies supporting competitiveness in small and medium-sized
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FOREWORD

This handbook presents results from the research project *STRATEGO – Manufacturing strategies supporting competitiveness in small and medium-sized manufacturing enterprises (SMME)*. The project was carried out by researchers at the School of Engineering, Jönköping University, and Chalmers University of Technology, and was funded by VINNOVA within the program Production Strategies and Models for Product Realisation. A number of companies also participated in the project, for which we are deeply grateful! Thanks to your generous sharing of experiences and patience in testing new versions of the tool, we came a little bit further. We also want to thank Mikael Cederfeldt for the Excel-programming, Mario Celegin for all illustrations, and Josanna Holmstrand at Husqvarna AB for contributing with photographs. Finally, we want to express our sincere gratitude to VINNOVA for giving us the opportunity to carry out this research project and especially to our project officer Margareta Groth.

The background to the project is that much of the work on manufacturing strategies has had the basic starting point in large companies and their conditions. Since SMMEs are in majority, and contribute considerably to financial development, it was considered important to focus on their competitiveness. Thus, there is a need to make knowledge on manufacturing strategies available and useful even to SMMEs, which is the aim of the STRATEGO project. We hope that we have contributed to that aim.

Together with the participating companies, we have developed a framework aiming to support companies in their work with manufacturing strategies. The framework consists of two parts, an analytical tool and a collection of guidelines. The STRATEGO tool and its guidelines are being presented in this handbook.

Jönköping and Gothenburg, October 2014

Kristina Säfsten, Mats Winroth, and Malin Löfving

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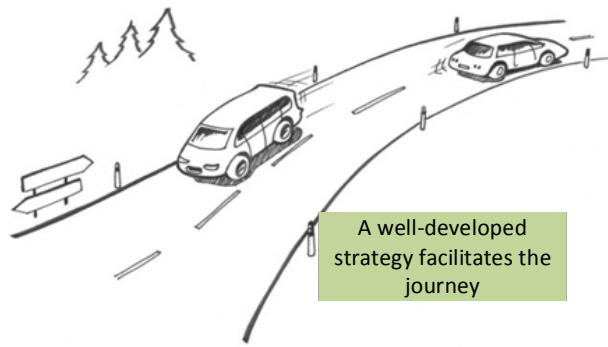
MANUFACTURING STRATEGIES

World-class production, including an ability to make the right products, with right quality, on time, and to a competitive cost, is required in order to compete successfully on an international market¹. A well-developed and implemented manufacturing strategy may constitute a support in this effort. Manufacturing strategy can simply be described as a specification of requirements for production. A number of decisions within several areas (decision categories) provide support for the production capabilities, leading to companies winning orders, competitive priorities.

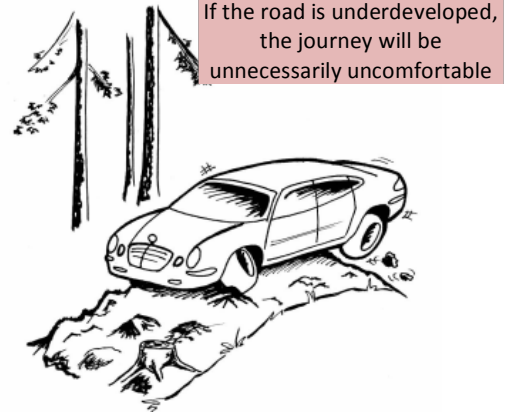
The awareness of production's importance for competitiveness is presently fairly good. An important prerequisite is however that production contributes to companies reaching their overarching targets. By working systematically with their manufacturing strategies, small and medium-sized enterprises (SMEs) can improve their ability to handle and adjust their production systems to support relevant markets and thereby reach competitive advantages on an international market.

Take a parallel to driving a car. The car symbolizes a company and its operations. The road symbolizes the strategy, i.e. how the company chooses to position itself and how to compete on the market. If there is a good road, suitable for driving the car, the path towards the target is facilitated – competitive production! If, on the contrary, the road is bumpy and not suitable, the journey will be unsafe and less comfortable.

¹ The text on manufacturing strategies is collected and further elaborated on from *Production Development: Design and operation of production Systems*, Springer, London. (Bellgran and Säfsten, 2010).



A well-developed strategy facilitates the journey



If the road is underdeveloped, the journey will be unnecessarily uncomfortable

A manufacturing strategy comprises a number of decisions within different areas that support a company's competitive advantages. In order to formulate an appropriate manufacturing strategy, the content needs to be well thought through as well as widely accepted within the company. The content is normally described in terms of competitive priorities and decision categories. Competitive priorities describe the targets at which the company aims, whilst decision categories relate to the decisions supporting the fulfilment of these targets. Common competitive priorities are related to quality, deliverability, flexibility, and cost. Frequent decision categories are production process, capacity, facilities, vertical integration, quality, human resources, organisation, and production planning and control. In the coming sections the most common competitive priorities and decision categories are described.

Competitive priorities (targets) and examples of relevant measures

Frequently described competitive priorities are different aspects of quality, deliverability, flexibility, and cost. It is important that a company is aware of the most important aspects in order to compete successfully, as well as how well they perform. Thus relevant measures need to be defined for each competitive priority. The most common competitive priorities as well as a few examples of relevant measures are described. It is important that the measures are defined so that they support reaching the targets, thus providing indications on how well operations are being directed.

Quality

Quality as a competitive priority is often related to the ability to satisfy customer needs and expectations, i.e. make products corresponding to customer requirements. Quality can be about customer's perception (a higher value) or conformance to requirements (less faults).

Possible measures: Quality yield, number of complaints, warranty returns, number of defects, cost for rework, quality of incoming components, MTBF (Mean Time Between Failure)

Deliverability

Deliverability as competitive priority refers to the ability to deliver, where important aspects are accuracy (reliability) and speed (time). Deliverability is the ability to deliver according to plan. Order lead-time is the time from order to delivery.

Possible measures: Cycle time, takt-time, time from supplier, inquiry time, lead-time, share of deliveries on time, average delay, number of products in stock.

Flexibility

Flexibility is the competitive priority dealing with the ability to swift and efficiently being able to adapt production to necessary changes. This is often about managing varying volumes, volume flexibility, or the ability to manage different product variants within a given volume, product mix flexibility. There are however a large number of other flexibility aspects.

Possible measures: Set-up time, time to develop a new product, number of product variants, time for changing production planning, smallest possible order size, number of options, share multi-skilled workforce

Cost

Cost as a competitive priority refers often to company's ability to produce and deliver to a low cost, i.e. being cost efficient. Costs may include material, workforce, and other resources required to make the product.

Possible measures: Production cost/unit, cost compared to competitors, productivity, cost for direct labour, utilization rate, OEE (Overall Equipment Efficiency)



				Plan	Utfall	Diff	Mtrl	Kommentar
M j	Måndag							
	Tisdag							
	Onsdag							
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Decision categories

Decision categories are the areas in which a company needs to make a number of decisions. Each category comprises a number of questions that the company needs to consider and make decisions about. See the table below for a quick overview and a few examples. These decisions shall support the chosen competitive priorities and are thus very important.

Decision category	Issues to decide upon (examples)
Production process	Process type, layout, level of technology
Facilities	Amount, acquisition time
Capacity	Location, focus, lead or lag capacity
Vertical integration	Direction, amount, relation
Quality management and control	Approach, responsibility, control
Human Resources (HR)/personnel	Responsibility appointment, competence
Organisation	Organisation, structure
Production planning and control	Choice of system, size of warehouse

Production process

The production process transforms resources into products. Decisions concern process type, layout, and level of technology and automation. The first decision, type of process, is strongly related to production volume and number of variants, i.e. how often the product reoccurs in production. Based on this, a categorization may be done into single piece flow, intermittent process (i.e. after certain intervals), and continuous flow process. Intermittent process may be with de-coupled or coupled flow of products. The other important decision, the physical location of different equipment in a workshop, relates to the chosen process type. Process types may be fixed position, functional layout (process oriented), batch flow system (cells), or line based layout (product oriented). Finally, a proper level of technology or automation needs to be decided. It may be divided into manual, semi automatic, or automatic production, depending on the degree of human involvement. The suitable level of automation depends on a number of circumstances that have to be taken into consideration.



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Facilities

Facilities concern the physical location where the production actually will be carried out. An important decision is the location of the premises and another one is the production focus of those premises. Production focus is one way of categorizing the connection between production and product. Process focus denotes a multi-purpose workshop, which may handle a large variety of products, whilst product focus tells us that it is dedicated to a single product or a limited number of products in large volumes.

Capacity

Capacity describes the possibility to carry out a certain activity over a defined period of time, often in terms of volume or quantity. Decisions need to be made regarding amount of capacity and when that capacity is requested. If the company wants to avoid the risk of under capacity, they may choose to invest in a lead strategy, i.e. the capacity precedes the actual demand. That decision needs to be based on the trade-off between costs for over capacity vs. cost for not being able to meet the demand and deliver on time. A capacity smoothing strategy means that the company is capable to keep pace with the actual demand.

Vertical integration

Vertical integration concerns how much control the company has over the supply chain. An important decision is what should be made internally or bought from external suppliers. Other aspects are e.g. developing own distribution channels or selling through retailers (amount). The direction of vertical integration may be down-streams (towards distributor, customer) or up-streams (towards suppliers). An increase of vertical integration in any direction gives more control over that part of the supply chain. A third decision deals with what kind of relationship the company wants to have with different actors up-streams or down-streams. Do they prefer ownership or could it be other forms of collaboration?

Quality management and control

Quality is both a competitive factor, i.e. what the company wants to achieve, and a decision category since the company needs to decide how they want to work regarding quality management and control. Proper work procedures need to be defined in order to guarantee that the quality demands are being met. The question whether to be reactive or proactive regarding quality is important. A reactive approach means more inspection, i.e. to detect errors so that no faulty products reach customers. A proactive approach requires preventive actions and process control. One important issue is about sharing of responsibility, which often is difficult to separate from action, i.e. the one who is responsible for a task is also responsible for the final quality. Many companies are today actively securing their processes, often by means of a systematic and certified quality management system.

Human resources (HR)/personnel

This decision category deals with questions such as sharing of responsibility and competence. Task distribution can be done in several ways. Two common ways are vertical and horizontal distribution. Vertical distribution distinguishes between planned and problem solving tasks and executing tasks, while horizontal distribution is division of the work process into as short time units as possible. An important issue is how tasks can be designed in the best way, both regarding human aspects as well as how to achieve best possible production effectiveness. Other issues are required competence, personnel flexibility and multi-competence, reward system, etc.

Organisation

Organisation deals with questions regarding organisation and structure. An organisation structure describes how the company is divided into departments and functions. The aim is to distribute work tasks in a way that utilizes available resources in the best way to achieve defined targets. Organisation structure reflects how the company regards works with its production.

Production planning and control

Decisions regarding production planning and control are about choice of principles for planning and control, both material and production. At different levels, different solutions show varying ability to support set targets. Planning needs to be done at different levels. At an overall level it is about planning for conformance between planned deliveries and available capacity. Next level secures that material and components are available when they are needed. The third level, detailed planning is nearest production and concerns order release to production and sequence planning.

Another decision within production planning and control is about stock size. Keeping stock normally leads to both increased cost and risks. A warehouse needs physical space, personnel, and equipment. Furthermore, there are risks that the products are no longer needed, that they get lost, or that they get damaged, so-called incurrence.

SMALL AND MEDIUM-SIZED ENTERPRISES

The EU-definition

A common definition of Small and Medium-Sized Enterprises (SMEs) is based on the number of employees and in Europe the definition developed by EU² is widely spread. In that definition the number of employees, turnover, and/or balance sheet total are included, see below. The definition also includes that the company should be independent, i.e. not more than 25% of the company may be owned by another company and the company itself may not own more than 25% of another company.

Category	# employees	Turnover	Or	Balance sheet total
medium-sized	< 250	≤ € 50 million		≤ € 43 million
small	< 50	≤ € 10 million		≤ € 10 million
micro	< 10	≤ € 2 million		≤ € 2 million

The purpose of having a quantitative definition is e.g. to be able to identify which companies are eligible for getting funding from different financiers and support programs.

SME characteristics

There are a number of SME characteristics, besides the number of employees³. The most obvious is probably limited resources in terms of leadership, workforce, and financial strength. Other distinguishing features are personal leadership, limited number of customers, presence on limited markets, reactive mentality often leading to “fire fighting” activities, and a flat and flexible organisation. Other SME properties are high degree of customer focus and limited interest for employee education and training⁴. The existing competence is also often towards technology and the products

² European Commission (2005)

³ Ghobadian och O'Regan (2000), Hudson *et al.* (2001)

⁴ Voss *et al.* (1998)

to be made rather than management and strategy⁵. Several of these characteristics may influence the ability to work with manufacturing strategies.

Advantages and disadvantages of being a smaller company

There are of course both advantages and disadvantages of being a smaller company⁶. A flat organisation provides short decision paths which leads to short information flows and fast decisions. This is a great advantage, both when formulating a manufacturing strategy and when it is ready to be communicated in the organisation. Personal leadership, and that top management often is close to operations, may also facilitate this communication. To benefit from management's closeness to operations, it requires that the management is committed and motivated to introduce a systematic work with manufacturing strategies and that they have knowledge on how to do it and what it really implies.

The largest disadvantage is probably the limited resources, which may call for a clear motivation and support by simple tools. One example is the STRATEGO-tool, which does not lead to any additional costs and it also does not require a considerable amount of time. The STRATEGO-tool was developed together with a number of SMEs, which guarantees that their needs and expectations have been considered in the tool. However, an introduction involving education and training is needed in order to create a common terminology and understanding of which work has to be done. This may be an obstacle in a small company. It is also necessary that the management can delegate and invite employees in order to create teamwork, which is important for the result.

⁵ Cagliano och Spina (2002)

⁶ Yosuf och Aspinwall (2000)

THE STRATEGO-TOOL

It is necessary that the manufacturing strategy is well formulated and established at the company in order to really make it supportive. There are several tools for formulating manufacturing strategies and in the STRATEGO-project, we have developed a framework that is particularly intended to fit the needs of small and medium sized manufacturing enterprises, SMMEs.

The framework consists of two parts, an analytical tool and a number of guidelines. They are both included in an Excel-program and together they are the STRATEGO-tool.

Brief description of the different steps

The different steps of the tool are further described below.

Form a suitable team: a multi-functional team with members from relevant functions, e.g. marketing, production, development, purchasing, top management (necessary), etc.

Carry out an analysis of the present status and formulate the manufacturing strategy with the following steps:

Where are we now?

1. Identify competitive factors
2. Go through decision categories
3. Assess present production
4. Carry out competition analysis

Where to are we heading?

5. Identify focus areas

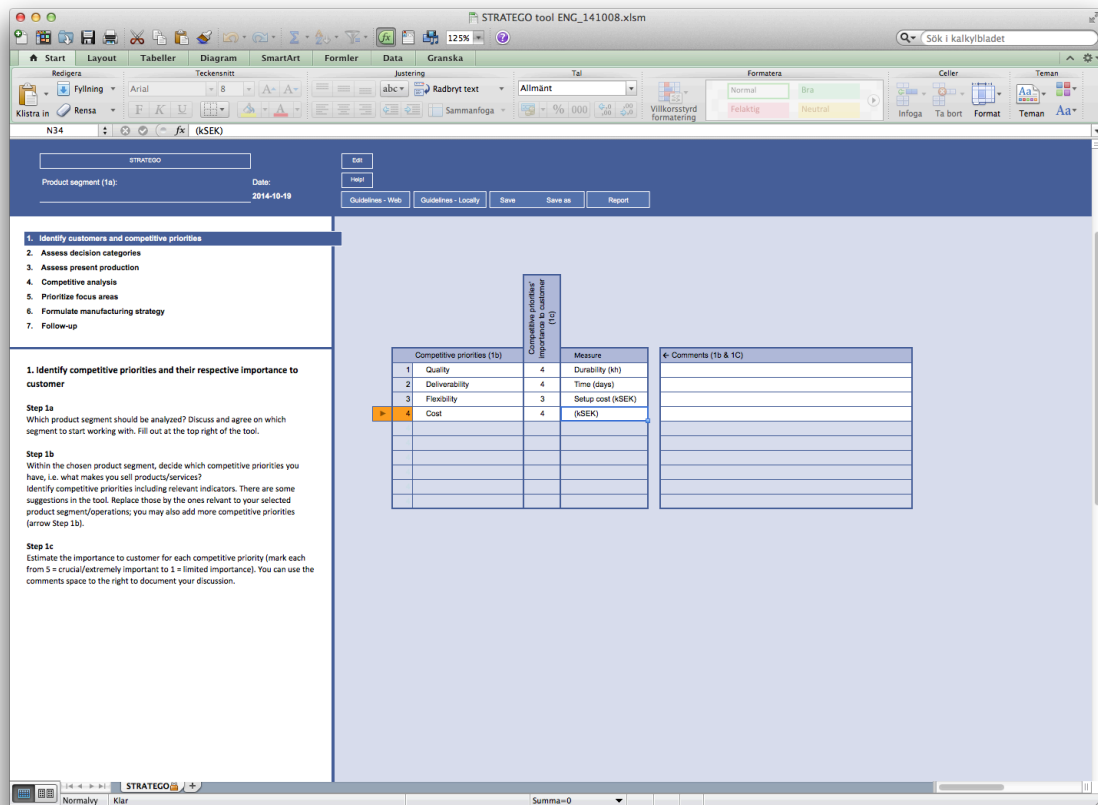
How do we get there?

6. Formulate manufacturing strategy
7. Follow up

Step 1. Identify competitive factors

Once a suitable group has been formed, the formulation of manufacturing strategies may start. First the focus product segment has to be decided (step 1a). For that product segment, identify present competitive factors including their respective measures (step 1b). Thereafter, grade the competitive factors according to their importance to customers (step 1c). Preferably the comments field to the right may be used to document how you discussed etc. On the next page you can see what it looks like in the actual tool. Arrows in the tool guide you in your work. Just press HELP button and you can see them!

- a. Which product segment is in focus? If the company has several product segments involving different conditions, each segment should be analysed. Therefore, start by selecting the segment to start working with. Fill out at the arrow Step 1a, at the upper left of the tool.
- b. Within the selected product segment, which competitive priorities do you have, i.e. why do you sell your products/service? Identify competitive priorities (targets) with relevant measures (KPIs) (target values are stated in Step 7). Some suggestions are given in the example on next page. Select the competitive priorities that are relevant for the selected product segment. You may also add additional competitive priorities (arrow Step 1b).
- c. Assess the importance to customer of each competitive priority. Grade from 5 (decisive/very large importance) to 1 (marginal importance). Fill out your importance assessment at arrow Step 1c.



Step 1. Identify competitive priorities

Step 2. Assessment of decision categories

The next step is to assess the means, decision categories, which can support the achievement of the identified competitive priorities factors. In the tool we have chosen to include the previously described decision categories.

1. Production process	5. Quality management/control
2. Facilities	6. Human Resources (HR)/personnel
3. Capacity	7. Organisation
4. Vertical integration	8. Production planning/control

- a. Estimate for each competitive priority to what degree the different decision categories contribute to achieving/maintaining a certain level of performance.

Use the scale:

1=decision category contributes to low extent,

2=medium level of contribution,

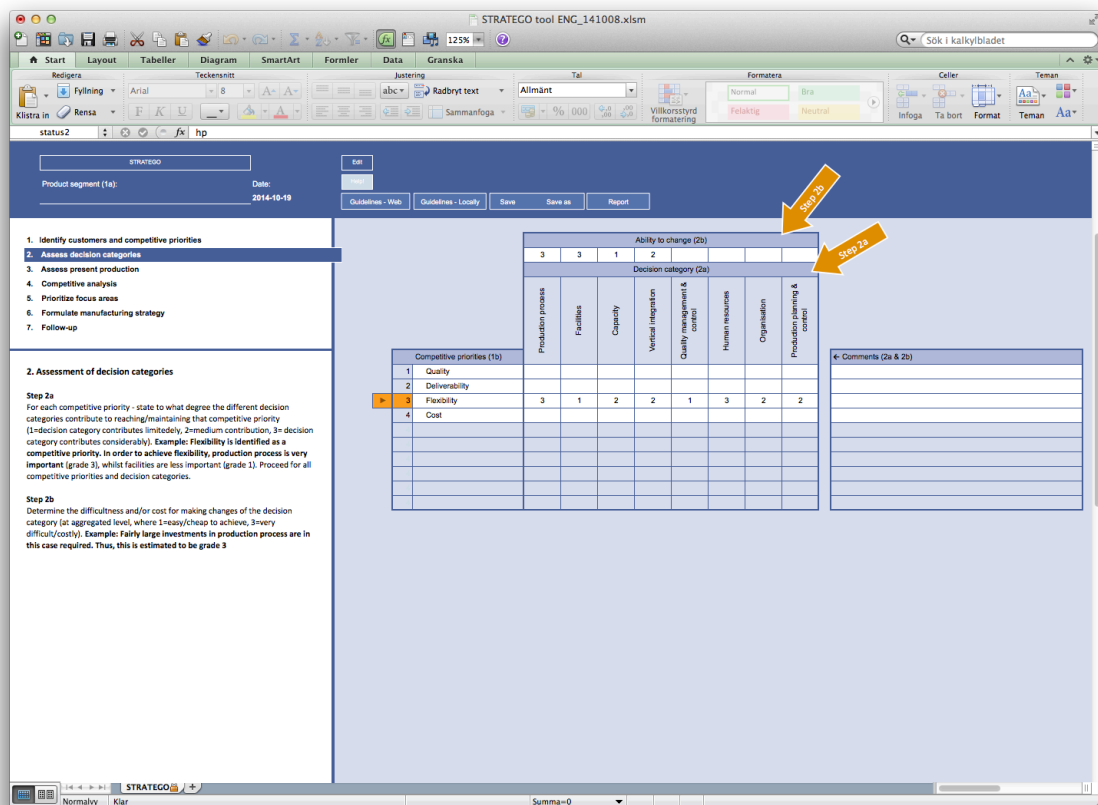
3= decision category contributes to large extent.

A scroll list is presented when the pointer is over a certain cell.

Example: Flexibility is identified as a competitive priority. The production process is extremely important for achieving flexibility (grade 3), while facilities are less important (grade 1). Proceed in this way for all competitive priorities and decision categories.

- b. In step 2b the ability to make change shall be estimated. Judge how difficult and/or costly it is to carry out changes of the different decision categories at an aggregated level, where 1=easy/cheap to achieve, 3=very difficult/costly.

Example: In this case, in order to make changes of the production process, fairly large investments are needed. This is thus judged as being costly, thus grade 3.



Step 2. Assessment of decision categories

Step 3. Assessment of present production

Now we have an overview of the present means for achieving the targets. We also get an indication about the possibility to change anything within each decision category (changeability). The third step is about estimating today's performance within each of the identified competitive priorities. It is important that this estimation is done honestly and that the company reach consensus regarding what to assess and why this is good or not. An extra field is available for documenting the consensus meetings.

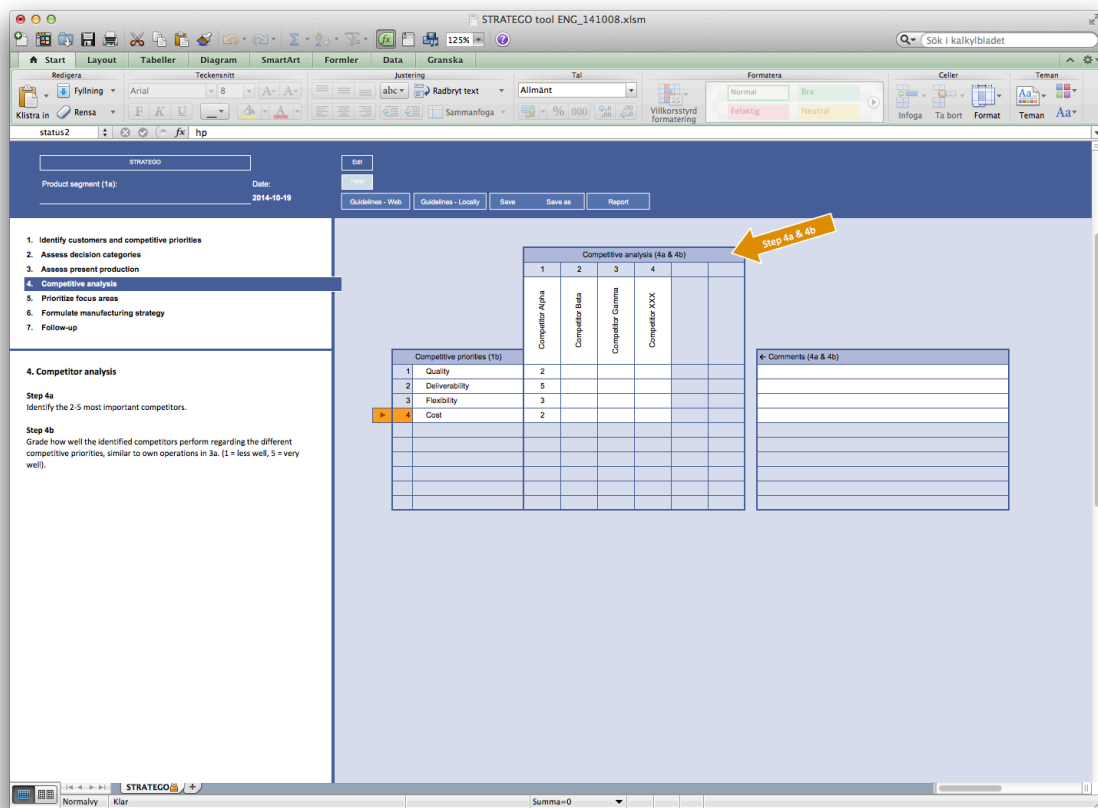
- a. How well do you perform regarding different competitive priorities? Judgement of the present state should be done on a scale 1-5, where 1 is less well and 5 indicates that the performance is very good.
- b. How does this relate to the identified customer demands? The analysis is automatic and the result is presented in Step 5. Yellow colour indicates a warning due to performance above customer demands, red indicates that actions are recommended due to performance under customer demands, and green means conformance to requirements i.e. leave it for now.

Step 4. Competitor analysis

The fourth step towards a well-formulated manufacturing strategy is to create an overview of the strongest competitors. The purpose is to indicate the present market position and to highlight the own company's, as well as the competitors', strong capabilities. This is useful knowledge when starting to prioritize future activities. Judging competitors capabilities may be hard. Do as well as possible and try to be honest! Also in this step it is of outmost importance to dedicate time and to document the discussion.

- a. Identify the 2-5 strongest competitors. Fill out the name of the competitor in the right hand part of the matrix.
- b. Judge how well the identified competitors perform regarding the different competitive priorities, similar to how the own company's performance was evaluated in 3a. The grades are from 1, less good performance, to 5, very good performance.

Example: *You have identified Competitor Alpha as one of your most important competitors. Then, judge how well they perform within the identified competitive priorities. In the example on next page, the judgement is that their performance regarding quality is 2, delivery 5, flexibility 3, and cost 2. The alternatives are in the scroll list, which is visible when the pointer is over the actual cell in the matrix.*



Step 4. Competitor analysis

Step 5. Prioritize focus areas

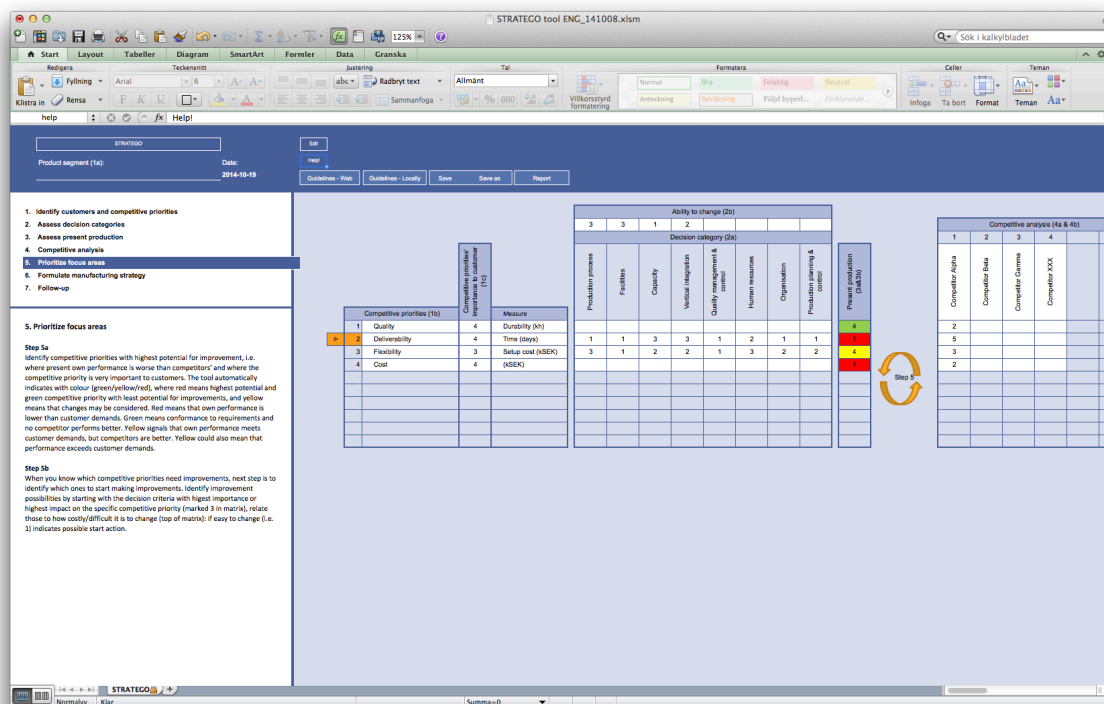
The fifth step involves a considerable amount of “own” work. The tool provides a base for own discussions on what to prioritize and how it can be done. Step 5 and 6 are closely related. The outcome from discussions in step 5 is to be documented in step 6.

- a. Identify the competitive priorities with the highest potential for improvement, i.e. where the own performance is worse than the competitors and the priority is very important to customer. The tool automatically provides a colour signal (green/yellow/red), where red indicates highest potential and green the least potential. This provides guidance for what should be prioritized.

Example: On the next page delivery and cost are marked red. Concerning delivery, your own capability is judged to be less good (1), whilst it is considered important for customer (4), which gives a signal on that we can see a high improvement potential. In order to get additional support for deciding what should be prioritized, the assessment of competitors' capability can be used. In this example, Competitor Alpha's delivery performance is very good (5), which makes it suitable to start by investigating how the own delivery performance can better match customer expectations.

- b. When you know which competitive priorities need improvement, next step is to identify which decision categories to start making improvements. Identify improvement possibilities by starting with the decision categories that have the highest impact on the actual competitive priority (marked 3 in the matrix) and relate those to how difficult/costly it is to change (at the top of the matrix); if it is easy to change (i.e. 1), it may be suitable to start there.

Example: Start by looking at deliverability. In the example on next page, the decision category capacity is considered important for deliverability (3). Furthermore, capacity is considered to be simple/less costly to change (1), thus making this a possible start for discussing further actions.

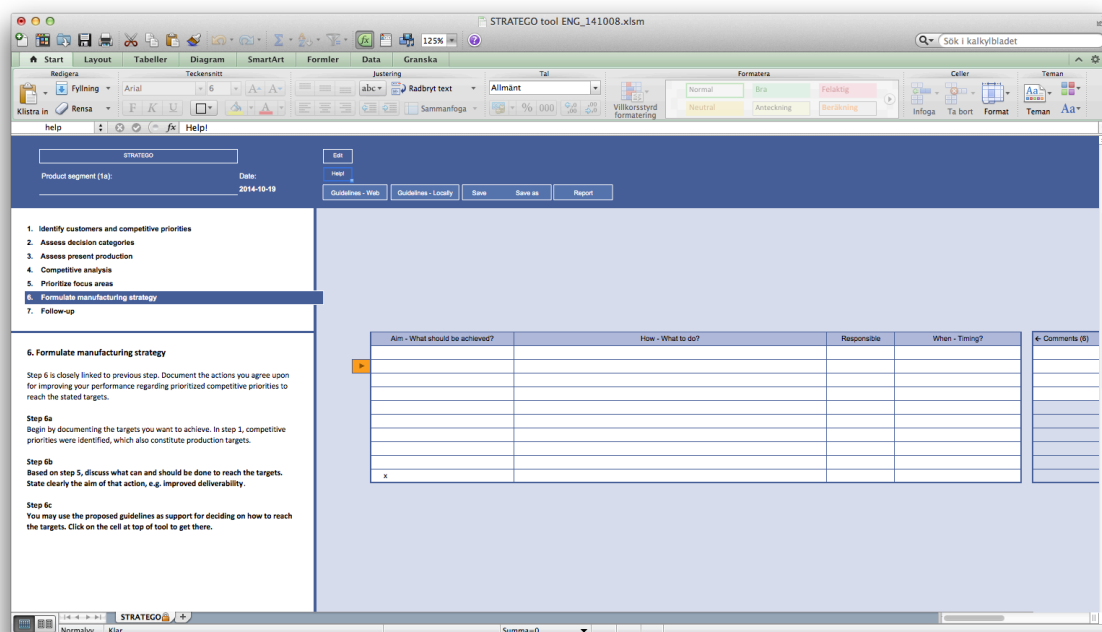


Step 5. Prioritize focus areas

Step 6. Formulate manufacturing strategy

Step 6 is closely related to step 5. It starts by documenting the targets that were formulated in step 1 (identified competitive priorities). Thereafter, the agreed actions for reaching the formulated targets, and thereby improving the competitiveness, are documented.

- a. Start by formulating the targets you want to achieve. In step 1 the competitive priorities were identified, which should be broken down into targets for production.
- b. Outgoing from step 5, try to reach consensus on what may and should be done to reach the targets. State clearly what the action is expected to contribute to, e.g. improved deliverability.
- c. As support for determining what can be done to reach the targets (prioritized competitive priorities), the tool's guidelines may be used. To get there, just click on the cell at the top of the matrix.

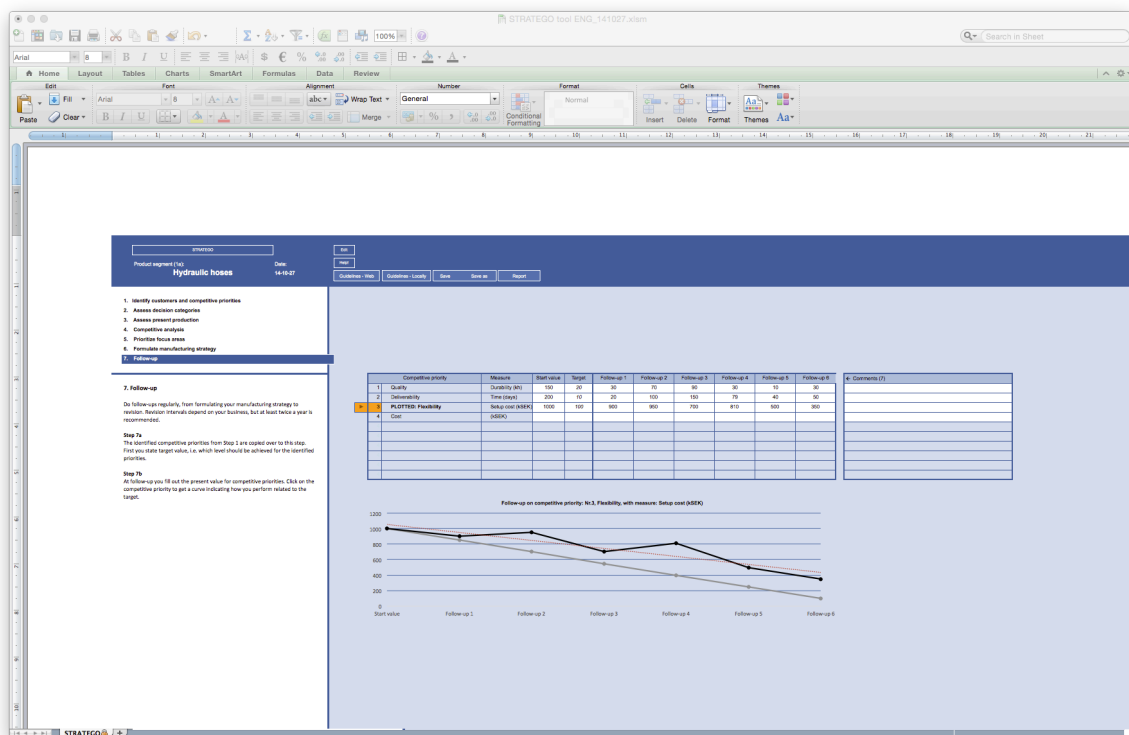


Step 6. Formulate manufacturing strategy

Step 7. Follow up

The progress should be followed up regularly, from formulation of the manufacturing strategy until it is time to revise it. The interval depends on the actual operations, but at least twice a year is recommended.

- a. The competitive priorities (targets) identified in Step 1 are valid until this step. The first to be done is thus to fill out target value, i.e. the level to be achieved regarding the identified targets.
- b. At follow up, the measured value for the competitive priorities (targets), are documented. By clicking on the competitive priority, a curve is plotted indicating the present relation to the desired value.



Step 7. Follow up

GUIDELINES

As support, when formulating a manufacturing strategy, some guidelines are presented. They are based on experiences from previous cases on actions that have shown to be useful in achieving improvement of the own ability regarding competitive priorities. The guidelines are often in terms of questions with the purpose to facilitate discussions. Most guidelines are supported by comments, which may be clarifying, stating special things to consider, explanations to why this question is relevant or similar. Related to the guidelines, theoretical sources are provided in case further studies are requested.

Quality

Guidelines - quality		Comments
1	Can change in level of automation contribute to improved quality?	Automation does not in itself solve problems with undeveloped processes. High level of automation will in that case lead to increased complexity, higher cost, and more quality problems.
2	Can set-up times be reduced?	Short set-ups enable smaller batches and earlier detection of quality problems.
3	Can quality be improved through change in product or process?	The base for right quality is stable processes. Robust design may also make the product more insusceptible of a not entirely stable process.
4	Can suppliers be more, or differently, involved in order to improve quality?	The quality may be improved by working more closely a limited number of suppliers.
5	How can a quality management system support improved product quality?	Quality management systems (ISO 9001, ISO/TS 16949, etc.) provide a structure for operation management and control for achieving right quality.
6	How can quality measures be used for improving quality? Are they well known to all?	A clear feedback to employees is crucial for achieving long-term quality improvement. Measures should be clear and directly linked to the different manufacturing processes. Visual methods for showing the quality yield and where problems occur is good.
7	What opinion do employees have to quality and improvement work? Does the company encourage and support involvement?	Reward does not have to be in terms of bonus, but e.g. possibility for courses and training activities.
8	Is FMEA used for the product?	FMEA may improve quality. Clear linkage between design-FMEA and process-FMEA with cross-functional teams is essential.

Guidelines - quality		Comments
9	Are previous experiences being considered?	Continuous learning improves product quality.
10	Quality award systems (e.g. EFQM) may provide input when formulating manufacturing strategies.	EFQM (European Foundation for Quality Management) is a European organization supporting companies in their quality work.

Sources: Miltenburg (2005) (1, 2, 3, 4, 7), Säfsten *et al.* (2007) (1), Winroth *et al.* (2007) (1), Berk (2010), (2), Slack *et al.* (2011) (3), Bergman and Klefsjö (2002) (3, 5), Merino-Diaz De Cerio (2003) (5, 6), Kaynak (2003) (6), Kathuria *et al.* (2010) (7), Karim *et al.* (2008) (8, 9), Carlsson (2012) (8), Bou-Lousar *et al.* (2009) (10).

Deliverability

Guidelines - deliverability		Comments
1	Can Just-In-Time (JIT) be used to shorten delivery lead-times?	Which capability does the company have to make the order as closely to delivery as possible, in exactly the right quantity, and with right quality?
2	Can set-up times be reduced to shorten lead-times?	Set-up times state the economical batch size for production, thus being essential for JIT.
3	Can lead-times be reduced through changes in level of automation?	Higher level of automation may give higher productivity, but a balanced view, where the risks of higher complexity are considered, may be necessary.
4	May deliverability be improved by changing product or process?	Stable processes can be achieved through standardized work procedures, 5S, root cause analysis, etc.
5	Can cooperation with suppliers be improved to get material and components on time?	Internal and external suppliers need to cooperate and inform about their respective lead-times. Higher degree of involvement with suppliers, where everybody cooperates to improve suppliers' efficiency, can be very profitable and provide lower cost, improved quality, and improved deliverability.
6	How are employees informed about delivery times, i.e. planned and actual times as well as planning changes?	Clear information on customers' expectations often leads to more interest and involvement among employees. It is important for them to feel that they may influence.
7	Can production lead-time be reduced?	Value stream mapping (VSM) may provide a good overview over possible bottlenecks.

Guidelines - deliverability		Comments
8	Do you have lead or lag capacity strategy?	Overcapacity (lead) costs more but supports deliverability. Undercapacity (lag) reduces cost, but may lead to reduced sales, unsatisfied customers, if delivery demands are not being met.
9	How are late orders dealt with? Are they being prioritized?	Detailed planning must be done with correct data. Planning errors may affect delivery delay and a late order may lose priority in planning. If planning is “frozen” long time ahead, it may lead to problems in identifying late orders and their prioritization.
10	Are customer specific products being made (make-to-order, MTO) or standard products (make-to-stock, MTS)?	MTO: push system, long lead-times, manufacturing to known orders MTS: kanban system, pull system, JIT, fixed production scheduling
11	Do suppliers get status information continuously?	Time-to-market (TTM) can be reduced by involving and informing suppliers better.

Sources: Miltenburg (2005) (1, 2, 3, 4, 6, 7), Liker and Meier (2006) (4), Vachon *et al.* (2009) (5), Slack and Lewis (2008) (8), Wacker and Sheu (2006) (9, 10), Olhager and Rudberg (2002) (10), Hill and Hill (2009) (10), Danese and Filippini (2010) (11).

Flexibility

Guidelines - flexibility		Comments
1	Can flexibility be improved by changing product or process?	A switch to modularized products may provide an improved possibility to provide customized products, with improved and more standardized manufacturing process
2	Can flexibility be improved through automation?	High level of automation may contribute to improved volume flexibility.
3	Can flexibility be improved through organisational change?	Wider competence among employees, enabling them to carry out more different work tasks, provides increased flexibility
4	Can changes in purchasing routines increase flexibility?	Larger purchasing quantities reduce price, but lead to increased cost for inventory and a risk of unsold products. This choice is directly linked to suppliers' lead-times.
5	How is collaboration with suppliers organized?	Formal collaboration leads to lower flexibility. Long-term relations may increase flexibility.
6	Can a product be moved between machines/lines?	Re-routing possibility may contribute to increased product mix flexibility.
7	Can SMED (set-up time reduction) be used to improve flexibility?	Demand driven production (incl. reduced batches and set-ups) increases speed and reduces cost for changes of mix of present products and new product introduction.
8	Are all bottlenecks known? Is it possible to use free capacity in another machine when the bottleneck machine is being set-up?	Reduction of set-up time in bottlenecks can increase product mix flexibility.
9	Are production routines standardized?	Standardized work procedures, with stable processes, are the key to improvements.

Guidelines - flexibility		Comments
10	How large parts of supply chain can be handled? What does vertical integration look like?	Many activities downstream (towards customer) may reduce flexibility.
11	Are employees multi-competent?	Multi-competent employees may contribute to improved product mix flexibility.
12	Are customized products or standard products offered? Are products made to stock, to order, etc?	A very important strategic decision affecting the entire company. It is about competitive positioning.
13	Does maximum capacity meet maximum demand?	Volume flexibility is enabled if maximum capacity meets maximum demand.
14	Do you have lead or lag capacity strategy?	Instead of increasing own capacity, volume flexibility may be improved by acquiring extra capacity from external suppliers.
15	Do measures at operative level correspond to the strategic targets on change of flexibility?	Strategic targets on flexibility must be supported by measuring and rewarding the flexibility reached.
16	Can flexible workforce be used to balance fluctuations?	Volume flexibility may be achieved by means of flexible workforce.
17	May lean and agile production be reached?	Agile is about flexibility, lean is about customer satisfaction, which are two aims that can be combined.

Sources: Miltenburg (2005) (1), Lucas and Kirillova (2011) (1, 2, 3, 16), Surez et al. (1995) (2), Hutchinson and Das (2007) (2), Hallgren and Olhager (2009) (3), Esturilho and Esturilho (2010) (3), Gimenez *et al.* (2012) (4), Vachon *et al.* (2009) (4), González-Benito (2010) (4), Koulikoff-Souvireon and Harrison (2008) (5), Cousens *et al.* (2009) (6, 8, 9, 11, 13, 14, 15, 16), Laugen et al. (2005) (7), Bozarth *et al.* (2009) (10), Wacker and Sheu (2006) (12), Salvador et al. (2007) (12), Inman *et al.* (2011) (17), Narasimhan *et al.* (2006) (17).

Cost

Guidelines - cost		Comments
1	To what extent is production automated? Can change in level of automation contribute to improved cost efficiency?	High level of automation may lead to increased complexity and higher cost.
2	Can changing product or process reduce cost?	Improved quality may reduce cost.
3	Can set-up times be reduced?	Reduced set-up times enable smaller batches, thus lower inventory and lower cost.
4	Can suppliers be more involved in development projects and production to reduce cost?	More collaboration in supply chain may reduce total cost.
5	Can quality management system be used to reduce production cost?	Improved quality may reduce cost.
6	Have all processes been investigated regarding share value adding time/activity (e.g. through value stream mapping)?	Eliminating waste reduces cost.
7	Can productivity be further improved? Is Overall Equipment Efficiency (OEE) measured?	Improved OEE provides positive effects on cost efficiency.

Sources: Miltenburg (2005) (1, 2, 3, 4), Brannemo (2006) (4), Gimenez *et al.* (2012) (4), Vachon *et al.* (2009) (4) Laugen *et al.* (2005) (4, 7), Koulikoff-Souvrin and Harrison (2008) (4), Bergman and Klefsjö (2002) (5), Merino-Díaz De Cerio (2003) (5), Kaynak (2003) (5), Liker and Meier (2006) (6).

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STRATEGO

Manufacturing strategies supporting competitiveness in small and medium-sized manufacturing enterprises – a handbook

We have, within the research project STRATEGO, developed a tool intended to support small and medium-sized manufacturing enterprises in their formulation of manufacturing strategies. The STRATEGO tool is implemented in Excel and can easily be accessed by contacting any of us.



Kristina Säfsten
School of Engineering,
Jönköping University
kristina.safsten@jth.hj.se



Mats Winroth
Operations Management
Chalmers University of Technology
mats.winroth@chalmers.se



Malin Löfving
School of Engineering,
Jönköping University
malin.lofving@jth.hj.se

This handbook provides support when you use the STRATEGO tool.

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