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Citation for the original published paper (version of record):

Winroth, M., Säfsten, K. (2018). Research Results Improve Learning and Understanding in Master Courses - The use of a manufacturing strategy tool. *Procedia Manufacturing*, 25: 47-54.
<http://dx.doi.org/10.1016/j.promfg.2018.06.056>

N.B. When citing this work, cite the original published paper.



Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 25 (2018) 47–54

Procedia
MANUFACTURING

www.elsevier.com/locate/procedia

8th Swedish Production Symposium, SPS 2018, 16-18 May 2018, Stockholm, Sweden

Research Results Improve Learning and Understanding in Master Courses – the use of a manufacturing strategy tool

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Abstract

The analytical STRATEGO-tool has been used in total 48 project groups in master courses at Chalmers University of Technology from spring term of 2015. The project trains the students in applying theoretical tools at real organizations with a specific interest in analyzing their use of operations strategy. This paper presents the outcome from these courses and specifically discusses its usability as a pedagogic tool in different contexts, even though the intention with the tool initially was to constitute a tool for SMEs who wanted to develop their manufacturing strategies.

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Peer-review under responsibility of the scientific committee of the 8th Swedish Production Symposium.

Keywords: Operations Strategy, Analytical framework, Teaching

1. Introduction

Formulation of manufacturing strategy is often described in terms of a procedure [1], methodology [2], or framework [3,4]. Despite the vast number of suggested frameworks, the usability of these is seldom considered. There are of course a few exceptions. Common characteristics of strategies have been identified and grouped into procedure, participation, project management, and point of entry [2]. Many of these characteristics focused on organisational aspects and less focus was linked to the actual framework aimed at developing the strategies. With a starting point in

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identified characteristics of successful formulation [2], Löfving *et al.* [5] suggested a set of assessment criteria categorised into procedure (e.g. simple and easy to understand, specific steps, etc.), realisation (e.g. participation, resourcing, etc.), and contextual issues (e.g. company size). Apart from issues related to the procedure of using a framework and contextual issues, usability also includes aspects related to the achieved result [6].

Usability of a manufacturing strategy framework is one of the aspects that need to be considered if a framework should contribute to making manufacturing strategy accessible and applicable to SMEs. Usability, referred to as a measure of the success of a software, computer system, or product, is commonly discussed within areas such as human-computer interaction, man-machine interaction, ergonomics, etc. (Nielsen, 1993). In this context, usability is defined as “*the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use*” [6]. According to the same standard, effectiveness refers to the accuracy and completeness with which the users achieve specific goals, efficiency refers to the resources expended in relation to the accuracy and completeness of goal fulfilment, and satisfaction refers to freedom of discomfort, and positive attitude to using the product. Other attributes of usability, mentioned in usability engineering, are learnability and memorability. Learnability means that the system should be easy to learn so that the user rapidly can start work with the system and memorability refers to the that the system should be easy to remember so the user easily can return to the system after some time not using it, without having to re-learn everything [7]. The STRATEGO-tool was developed according to these criteria, however focusing on manufacturing SMEs.

To take the discussion on usability of a manufacturing strategy framework one step further, the usability of research results in teaching situations is investigated. The purpose of this paper is to describe the usability of a specific analytical tool[†], the STRATEGO-tool [8,9].

Four main questions were raised:

1. How was the usability of the tool as a means to support learning on manufacturing strategies in a master program?
2. Which results were achieved by the students using the tool?
3. What is applicable in different contexts?
4. Which effects (in terms of fulfilment of the Intended Learning Outcomes, ILOs) did it give to the students?

2. Course syllabus and learning outcomes

The course in Manufacturing Strategy is designed to equip students with practical frameworks and models for implementing and analysing manufacturing strategies. The main aim of the course is to improve students’ ability to develop and analyse manufacturing strategies. The starting point is to analyse manufacturing by means of its manufacturing strategies. Having done that, possible differences between the present status of manufacturing and the intended status can be detected. Finally, different improvement approaches will be discussed.

Having successfully completed the course, the student should:

- Be encouraged to analyse manufacturing processes, through having acquired knowledge of a number of organising theories, frameworks, and analytical methods.
- Have acquired a number of conceptual tools for improving the performance of manufacturing processes.
- Be able to apply these tools to the analysis of manufacturing processes.

The course consists of a maximum of 100 points, including possible seminar points, max 10. To pass the course, a total minimum of 40 points are needed, for which a grade of “3” will be awarded. A total result of 60-79 points will result in the grade “4”. The highest grade “5” will be awarded for 80 points and over. The following parts are included in the examination:

Individual written exam – worth 50 points

[†] STRATEGO-project, run 2010-2014, was financed by VINNOVA, the Swedish Governmental Agency for Innovation Systems, as a collaboration between Jönköping University and Chalmers University of Technology

- The exam will consist of 5 essay questions, worth 10 points each. The exam will be designed to test your knowledge and understanding of the course material. Examples of questions will be provided close to the exam.
- The result on the exam will count towards 50% of the total grade, equivalent to 50 out of 100 points.
- You need at least 20 points on the exam to pass the course.

Group project – worth 40 points

- Students will in groups of 4 - 5 students conduct a manufacturing strategy analysis of an organisation.
- The result on the group project will count towards 40% of the total grade, equivalent to 40 out of 100 points.
- The project is to be reported both in writing (35 points) and through oral presentations (5 points).
- Groups need to score at least a total of 16 points on the project (report and presentation taken together) to pass the course.

Literature seminars maximum 2 points for the leading group

There are a number of compulsory seminars in the course, where the relevant research articles are being presented and discussed. The articles should be studied in advance to enhance a good discussion around the material. The seminars are led by student groups and run as discussions around a few questions (but not limited to):

- Capture the topic and content
- Choose a case for the seminar to show the practical application of the topic
- Lead a good discussion

As there are several articles for each seminar, the responsible group can arrange the discussion around the total picture provided by all the articles instead of one discussion on each article. Often there are different methods being used, which can make the overall results more relevant. Each group is responsible for leading one seminar. If the group performs very well in this task, they may be rewarded with one or two points.

Seminar reflections – maximum 8 points (max two for each seminar)

- Prior to each seminar, all students shall upload personal reflections on the content on Ping-Pong (a course portal), 400-600 words. These shall be reflections and not just summaries. Not sending in in advance or not attending the seminar requires a longer reflection of 1500 words. Note that the reflections should demonstrate that the student has understood the content in each article, but focus mainly on combined reflections on all articles in the topic! Good reflections, well developed, and clearly providing own thoughts may be rewarded with one or two points. These seminar reflections are not intended for the group leading the seminar, since they are supposed to read the material well anyway.

Course literature:

- Slack, Nigel & Lewis, Michael (2015), *Operations Strategy 4th ed*, Pearson Education, UK, ISBN: 978-1-292-01779-2 [10]
- STRATEGO-handbook [9], excel tool, and information pamphlet for presenting to companies
- Seminar articles on the following topics (examples):
 - General manufacturing strategy [11,12]
 - Production process development [13,14]
 - Strategic alignment [15,16]
 - Knowledge and creative processes [17,18]
 - Business Process Outsourcing [19,20]
- Special lectures on the following topics:
 - Setting-up an International Production System given by Professor David Bennett, Chalmers and Aston Business School [21,22]
 - Strategic consensus given by Assistant Professor Nina Edh Mirzaei, Jönköping University [23] [24-26]

3. 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 STRATEGO-tool, including suggested further readings, was published in a handbook by Säfsten et. al. [9].

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.

Steps in the process

Form a suitable team with members from relevant functions, e.g. marketing, 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

The outcome of these steps is fed into the Excel-tool and the outcome of the strategic analysis (after step 5) is shown in fig 1.

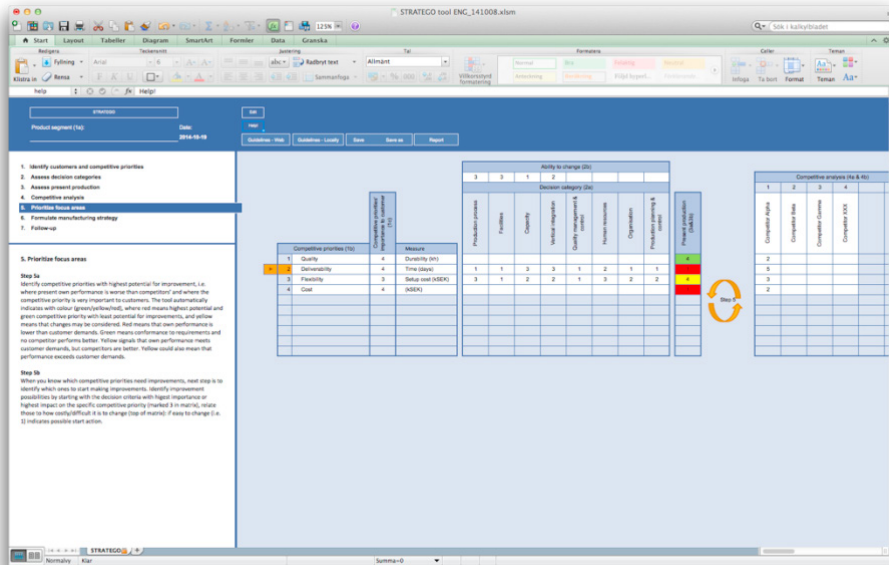


Fig. 1. Result from strategic analysis after step 5, will be base for formulating suitable actions.

After step 5 analysis, suitable actions are identified, plans for improvements are defined, and finally, after implementation of improvements, the outcomes are measured and assessed towards intended results. Normally, it is not possible for the students, due to time limitations, to follow steps 6 and 7, i.e. to formulate manufacturing strategy nor to see any effects from implementing it.

4. Using the STRATEGO-tool in the two master courses

Although intended for formulating manufacturing strategies in manufacturing SMEs, one idea was to try to use the STRATEGO-tool in manufacturing strategy as well as operations strategy master courses at Chalmers University of Technology. These courses include assessing existing operations and determine if the way operations are organised fits the intended market requirements. Furthermore, these operations can be carried out by manufacturing companies, service companies, public authorities etc., both large organisations and small ones. Thus, one main question was if this tool was useful at all for this purpose, which is quite different from what the tool was designed for.

The tool was used in a total of 48 student projects in two master courses at Chalmers University of Technology during the spring terms of 2015-2017. The projects train the students in applying theoretical tools at real organisations. The organisations are mainly from different industrial fields but also from service organisations, such as health care and education. It is also up to the students to propose organisations, contact them, and arrange company visits for carrying out interviews and visual study of existing operations (if possible to study).

The tool was developed with the intention to help small and medium-sized manufacturing enterprises in their work with developing their manufacturing strategies. Thus, it is a somewhat different situation when students go out to companies and apply the tool in a more assessment approach. The organisations could also often be much larger than intended. The tool was also not developed together with service organisations, so that is yet another aspect to see if it would work or not in this context.

Prior to having this tool, students in previous course rounds interpreted the task quite differently and the quality of the reports varied considerably. The prerequisite was to apply the Operations Strategy matrix, as described by Slack and Lewis [10], together with any complementary analytical tool, e.g. the Importance Performance matrix or similar. Many aspects from these analytical tools are now included in the STRATEGO-tool, meaning that students, instead of trying to find suitable tools, can focus on making thorough analyses and writing good reports.

After a short start-up phase, when the major part of the theoretical material is presented and discussed, the students contact companies/organisations and make appointments with key persons, i.e. people with market as well as operational knowledge. This may very well be combined in the same person, but normally, at least for somewhat larger organisations, this means interviewing several persons. If the organisation has a physical production system, a guided tour through the premises is also interesting. The students can use some marketing material developed in the STRATEGO project, i.e. a handbook, a pamphlet indicating the benefit for the company, as well as a tool programmed in Microsoft Excel which will be used to facilitate the analysis.

The two courses in 2015-2017 were TEK-156 Operations Strategy and TEK-195 Manufacturing Strategy, with around 60 and 30 students respectively. The project groups consisted of about 4-6 students, with a mix of Swedish and international students. It is an advantage to have knowledge in Swedish language in order to make interviews out in industry, even if most people are quite proficient in English. The interviews were made with someone from marketing, who could cover market requirements and customer expectations, and someone from operations with knowledge on how operational decisions are being made. Sometimes, especially if the organisation is small, it could be sufficient just interviewing one person, perhaps the CEO.

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The projects dealt with organisations of different types, see Table 1.

Table 1 – Projects and organisations

Service or Products	Size	Number of projects
Service	Small	12
Products	Small	13
	Medium	11
	Large	12

From Table 1 we can see that there is a large variation in size of organisation among these 48 projects. 3 organisations belong to healthcare, 9 other services, 4 electronic industry, 4 grocery manufacturing, 1 public higher education, 2 software industry, 1 retail, 1 chemical, and 23 companies belong to manufacturing industry.

4. Findings

The findings indicate that the STRATEGO-tool is quite generic and applicable to all kinds of organisations. The decision criteria are locked and not possible to change, since all organisations more or less need to address them all. The competitive priorities are however not fixed and it is possible to develop them based on the specific needs of the organisations. It may also be that the organisation not only wants to investigate the external expectations from customers, but also internal expectations from corporate management or owners. Thus, these targets may also be added to the framework.

All projects provided interesting results, even if some interviewees thought that the approach did not suit their specific situation, e.g. at the emergency clinic. The motivation for that statement made by the physicians was however somewhat awkward: “If we become more efficient, then it is impossible for us to go to our financiers (e.g. politicians) and ask for more money during an ongoing fiscal year”. There is obviously a huge difference in the way people at public service organisations regard the potential effects of improvement work compared to other sectors, which are under severe competition.

Since the introduction of the more structured methodology, provided by the STRATEGO-tool, the projects and reports improved considerably. Students could also focus more on the other aspects of the course, such as seminars and theory reflections.

Related to the four research questions, we can conclude:

How was the usability of the tool as a means to support learning on manufacturing strategies in a master program?

The tool has proven to be easy to use and it contains the necessary features for making an independent analysis of an external organisation.

Which results were achieved by the students using the tool?

The students’ reports improved considerably when the tool was introduced. The analyses are also much deeper and more focused on the actual operations strategy than previously

What is applicable in different contexts?

The student projects have mostly been focused on product manufacturing. We can, however, see that the STRATEGO-tool is applicable even in larger companies as well as in service operations. Service companies

have been consultancy firms, healthcare, and restaurants. One group even performed a study of the university and specifically of their own master's program.

Which effects (in terms of fulfilment of the Intended Learning Outcomes, ILOs) did it give to the students?

The students become trained in approaching a company or organisation, scheduling interviews, applying their theoretical knowledge on the operations at this organisation, analysing the operations, and presenting the results in a report.

5. What's in it for students and studied organisations?

Students' course evaluations have improved and presently they end up between 3.6 and 4.1 on a 5-degree scale. Previous course rounds, prior to using the STRATEGO-methodology, barely reached 3.0, due to the fact that students considered the courses to be too broad and unclear. By means of the STRATEGO-tool, the students get a clearer picture of how decision criteria and competitive priorities are related and how possible mismatches may be corrected. During evaluation meetings with the students, they are generally quite positive. The activities, they especially mention, are the project and the seminars. They also consider these activities, supported by "normal" lectures, to be sufficient and suggest that the final exam could be removed. We are currently investigating the possibilities to change the final examination. Since the grades are individual, and the projects are carried out in groups, there is however a need to find an individual examination as well.

The studied companies get a fairly objective assessment of their operations strategies. Many of these companies claim that they do have operations strategies, but they are not directly formulated and certainly not implemented. By taking part in student projects, and putting a few hours of time into them, they can get ideas on how to start working with their strategies. They also get feedback on what the students identify as suitable improvements in order to better provide what customers expect.

6. Relevance

This research is highly relevant in several aspects. One of the tasks for a university is to disseminate research results and make them available to the surrounding society. By using recent research in student courses this is made obvious and organisations are made aware of what is going on in academia. Another contribution is of course to validate the findings from the STRATEGO project and to see if the methodology is applicable to other kinds of organisations and also if it is possible to use it for strategy assessment and not only when working with strategy development internally.

Acknowledgements

The authors wish to thank VINNOVA, the Swedish Governmental Agency for Innovation Systems, for their financial support, as well as Chalmers Area of Advance on Production through its Sustainable Production Initiative.

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