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An Assessment Model for Production Innovation: The Program Production2030

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Abstract

The paper suggests an assessment tool for production innovation, a way of assessing innovation aspects in production development projects. The tool captures innovation as "new and value-added change of a production related activity". The tool was tested through a questionnaire survey sent to 30 research and innovation (R&I) projects funded by the Swedish Strategic Innovation Program Produktion2030, involving research institutions and industrial organizations. Results point at a varied distribution programme impact through resulting change activities. Identified areas for innovation were materials, decision support, tools, methods, and solutions estimated as new to industry and to the global business community.

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

Keywords: Production Innovation; Innovation assessment; Assessment tool

1. Introduction

The global manufacturing industry is undergoing a rapid shift from mainly manufacturing goods to satisfying ever increasing and varying needs of customers. For example, services and software are to a higher degree related to the physical products [1], and user experience is highlighted and valorized [2]. The change is on one hand driven by

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global competition with low cost production nations, low cost for goods transportation and information flow, and new technological possibilities (such as 3D printing and mass customization, e.g. [3]). On the other hand, there is a hunt for better margins. This shift takes place while facing significant challenges to convert industry to be more environmentally neutral (e.g. [4,5]). To address these challenges, a climate for innovation and well-developed abilities to industrialize new innovations is required.

Sweden has a long tradition of high-quality production, but need to constantly improve both innovativeness and efficiency to stay at this position. Competitiveness for Swedish industry in the long term is depending on innovation, high tech solutions and excellent environmental conditions, instead of low wages and un-prioritized workplace quality or environment-friendliness. At the same time, the innovation support system in Sweden has so far mainly focused on product innovation and business development. Seemingly taken for granted, production has previously rarely been regarded as an area to develop and support, except internally at the manufacturing firms, and were not often highlighted as Swedish strengths to lean on for future competitiveness. However, the increasing demand for innovative industry recently have generated the strategic innovation program Produktion2030 in Sweden, an initiative in coherence with similar initiatives around Europe, Japan and the US (e.g. Industrie 4.0 in Germany or the American AMI – Advanced Manufacturing Initiative). The objective of Produktion2030 is to ensure that Sweden remains to be a competitive production country [6]. One instrument to fulfil the objective is through Research and Innovation (R&I) projects and Test and demonstration projects. The projects within Produktion2030 are collaborative projects including several actors from industry, academia and research institutes. Focus has been on both early and more mature knowledge phases. Within the program, it is important to highlight and assess production innovation resulting from the projects to support investments, development and increased value in a production system. A production innovation can be viewed as a "new and value-added change of a production related activity", e.g. improved processes, better communication tools, simulation tools etc.

This paper presents a production innovation assessment tool with the purpose of highlighting, measuring and exemplifying innovation in production. The tool introduces a way of assessing innovation aspects in production development projects (ongoing as well as in retrospect), but also provides a learning opportunity during the assessment itself. The development of the tool is based on innovation measurement and assessment literature and pilot case studies of production innovation projects in different organizations. Results from first testing of the tool is also presented to show how the assessment tool can fulfil its purpose. With increased awareness and knowledge of production innovation we can understand its importance today and in the future, and the interest in industrial development, investments in production innovation and efforts in recruitment of young talents can be increased.

2. Assessment of innovation

Innovation can be described as: "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations." [7]. This definition implies that innovation encompasses a degree of novelty and/or improvement and also a completion of a process of change, i.e. implementation.

The success of an innovation project is difficult to define and measure since it is multi-faceted and strongly depends on the expected output [8,9]. There are various approaches to assessment and measurement of innovation, much dependent on the purpose. One way of approaching assessment is through separating the different stages of the innovation process. Some categorizations or assessments are done with regards to the intention or the initial state before development starts, e.g. innovation bias [10] or link to the life-cycle [11]. Other assessments are directed toward the development project, e.g. through ongoing evaluation (e.g. [12]) or success measures (e.g. [13,14]). Project performance in general can also be measured through e.g. time, cost, and process quality [15].

For the purpose of increasing the knowledge about production innovation to understand its importance, focus in the development of the assessment tool has been on the outcome and value creation parts. Outcomes of innovation can be characterized based on the type of change [16,17], and level of change in terms of amplitude and diffusion (e.g. [10,16,18]). Since diffusion is a time-dependent phenomenon, it can be valuable to assess diffusion based on factors influencing it [19], hence the potential for diffusion rather than the actual diffusion itself.

The effects of process improvement efforts can be gauged by various process performance indicators [20]. Another approach for assessment of effects of innovation in production is an adjustment of market performance dimensions, e.g. sales, profitability, market share [15], originating from product innovation literature. As production innovations are directed towards a production system rather than a receiving market, the market performance dimension can be translated into e.g (level of) use in production systems, unit cost of manufacture, manufacturing cost as percent of sales or inventory turnover [17]. An overview of literature embracing different aspects of assessment of innovation outcome and value is presented in Appendix A.

3. Production innovation assessment tool

The assessment tool for production innovation proposed in this paper constitutes of four parts; categorization of type of change, degree of novelty, value creation and implementation potential. The three latter ones are based on the constituting elements of innovation. Each part is described in the following sections.

3.1. Type of change

Production innovations can be changes in various sub-systems of the production systems: human, technology, information and/or management [21] or most often in a combination of them. To categorize the outcomes, a list of outcome types was produced based on literature and pilot cases. From interviews with managers at manufacturing firms, Schroeder et al. [17] draw up a list of types of new ideas in manufacturing, e.g. new management, control system, products or processes and material substitution or improvements. Yamamoto and Bellgran [16] separate between structural and infrastructural changes in their classification of manufacturing process innovation. Structural changes being e.g. changes in capacity of a factory or technology used in it, and infrastructural changes being e.g. changes in production control system, material flow, or organization.

Outcome types used in questionnaire are presented in Table 1. As it is difficult to make a comprehensible list that encompasses all possible production innovation, the possibility to choose “other” and add a comment on the type of outcome was added in the questionnaire.

Table 1. Explanations of outcomes types used in questionnaire.

Type of outcome	Explanation
Decision support	Information handling that supports business or organizational decision-making activities
Material	New or changed material and/or handling of material in production
Method	A procedure, technique, or way of doing something, in accordance with a definite plan
Process	A series of actions or steps taken in order to achieve a certain goal
System for quality control	System for review of the quality of factors involved in production
Technology	Knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment
Tool	An instrument used in performing an activity
Other	*Specified separately in comments*

3.2. Degree of novelty

Novelty is maybe the most recognized aspect of innovation, to be innovative is often more or less considered the same as being able to create and think new. The degree of novelty is in this assessment tool portrayed using the relation of the solution to previous knowledge, i.e. how big is the leap from existing solutions, and for how many this solution is new (individual, organization, industry, world). The relation to previous knowledge is measured along a scale from completely competence-enhancing to completely competence-destroying. Competence-enhancing innovation builds upon and reinforces existing competencies, skills, and know-how while competence-destroying innovation obsolesces and overturns existing competencies, skills, and know-how [18].

3.3. Value creation

The performance of a production system is frequently assessed in terms of parameters like productivity, efficiency, cost, quality, and time [21]. The effects of process improvement efforts can be gauged by various process performance indicators – common categories are cost, time, quality, or flexibility [20]. However, as sustainability is increasingly winning grounds in the spotlight, the different pillars of social, economic and environmental sustainability also increasingly become target measures for improvement efforts. Therefore, the value creation of production innovation is assessed using parameters of production system performance, process improvement effects and sustainability, presented in Table 2.

Table 2. Value creation parameters used in questionnaire.

Value creation parameters	Explanation
Cost	The cost of material, labor, and other resources to produce a product
Time	Time of a production related action or process
Quality	The level of performance and conformance to requirements
Environmental effects	Effects on the ecological capital, such as natural resources and eco-systematic functions
Social effects	Effects on social capital, such as human capital and societal capital
Economic effects	Effects on economic capital, such as tangible assets and equity

3.4. Potential for implementation

Implementation involve activities that occur between an adoption commitment and when the innovation cease to be new, is routine, or is abandoned [22]. The implementation process is affected by the characteristics of the supplier/seller as well as characteristics of the recipient/buyer and the interface between the two [23], but the technological fit in terms of familiarity and critical importance of the innovation will also have a major influence [23]. Five characteristics of an innovation are found to explain a large portion of the acceptance of it; relative advantage, compatibility, complexity, trialability and observability [19], see Table 3 for descriptions.

Table 3. Innovation characteristics explaining implementation [19].

Characteristics	Explanation
Relative advantage	the degree to which the innovation is perceived as better than the preceding solution
Compatibility	the fit and consistency with existing skills, practices, values, norms etc.
Complexity	the degree of difficulty to understand and/or use the innovation
Trialability	the possibilities to experiment with the innovation
Observability	the degree to which the results of the innovation are visible to others

Assessment of the degree to which an innovation comply with these characteristics will in advance give an idea of its potential for successful implementation. The knowledge of the level of compliance to the characteristics during an ongoing project might also influence the upcoming implementation positively as these aspects can be considered during development.

4. Initial results from production innovation assessment of Produktion2030 R&I projects

The tool was tested through a questionnaire survey sent to 30 R&I projects within Produktion2030 during spring 2016. The research and development projects in this program are collaborative projects including several actors from industry, academia and research institutes, but the questionnaire was directed toward project managers as they were thought to have the complete picture of the project. It was sent out as a web link via email to the respondents. Responses were collected from all 30 projects available in the program at the time of the study. The questionnaire consists of a main section with questions regarding general project information and subsections where results from the project was assessed separately, in terms of novelty, value creation, and potential for implementation.

Results point at a varied distribution program impact through resulting change activities. Identified types of change are presented in Table 4. As some projects delivered and assessed more than one result, the number of results assessed is larger than the number of projects.

Table 4. Type of changes in Produktion2030 R&I projects, n=36.

Type	Number of results in category	Percent of total
Decision support	5	13,9%
Material	3	8,3%
Method	10	27,8%
Process	3	8,3%
System for quality control	3	8,3%
Technology	5	13,9%
Tool	3	8,3%
Other*	4	11,1%

*Other include: knowledge, production system, test/evaluation, system

The projects results were estimated to be new to industry and/or to the global business community and had a normal distribution on the axis of competence-enhancing vs. competence-destroying, with a slight shift of the mean value towards competence-destroying (Fig. 3). Hence, results in the R&I projects were assessed to be quite novel, with leaps in knowledge and new to the "masses", which can be captured in the assessment tool.

The value parameters of cost, time and quality collected the highest number of answers, which were expected as these are the traditional production performance parameters most improvement efforts aim to improve. However, both economic and environmental effects were also mentioned as effects in many of the projects, indicating significance for value parameters other than the traditional production and process performance measures. Fig. 4 shows the effects from the projects on the different value parameters.

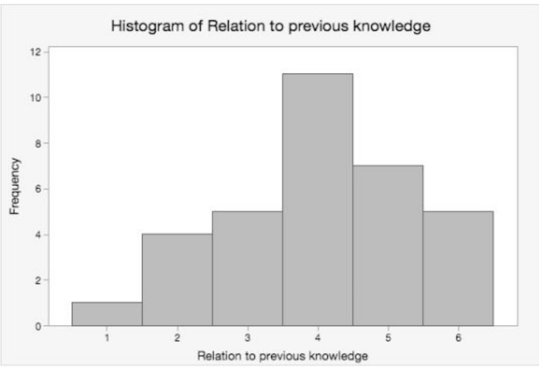


Fig. 3. Distribution of relation to previous knowledge (1=completely competence-enhancing, 7=completely competence-destroying), n=33.

Fig. 4. Value creation in R&I projects, n=134.

The potential for implementation was regarded quite high in the projects, with trialability ranked highest and non-complexity and compatibility ranked lowest (see Fig. 5), which is in line with the results showing a high degree of competence-destroying innovation.

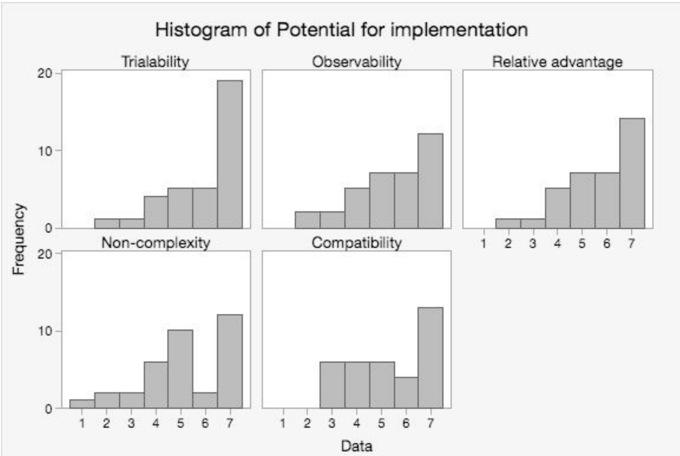


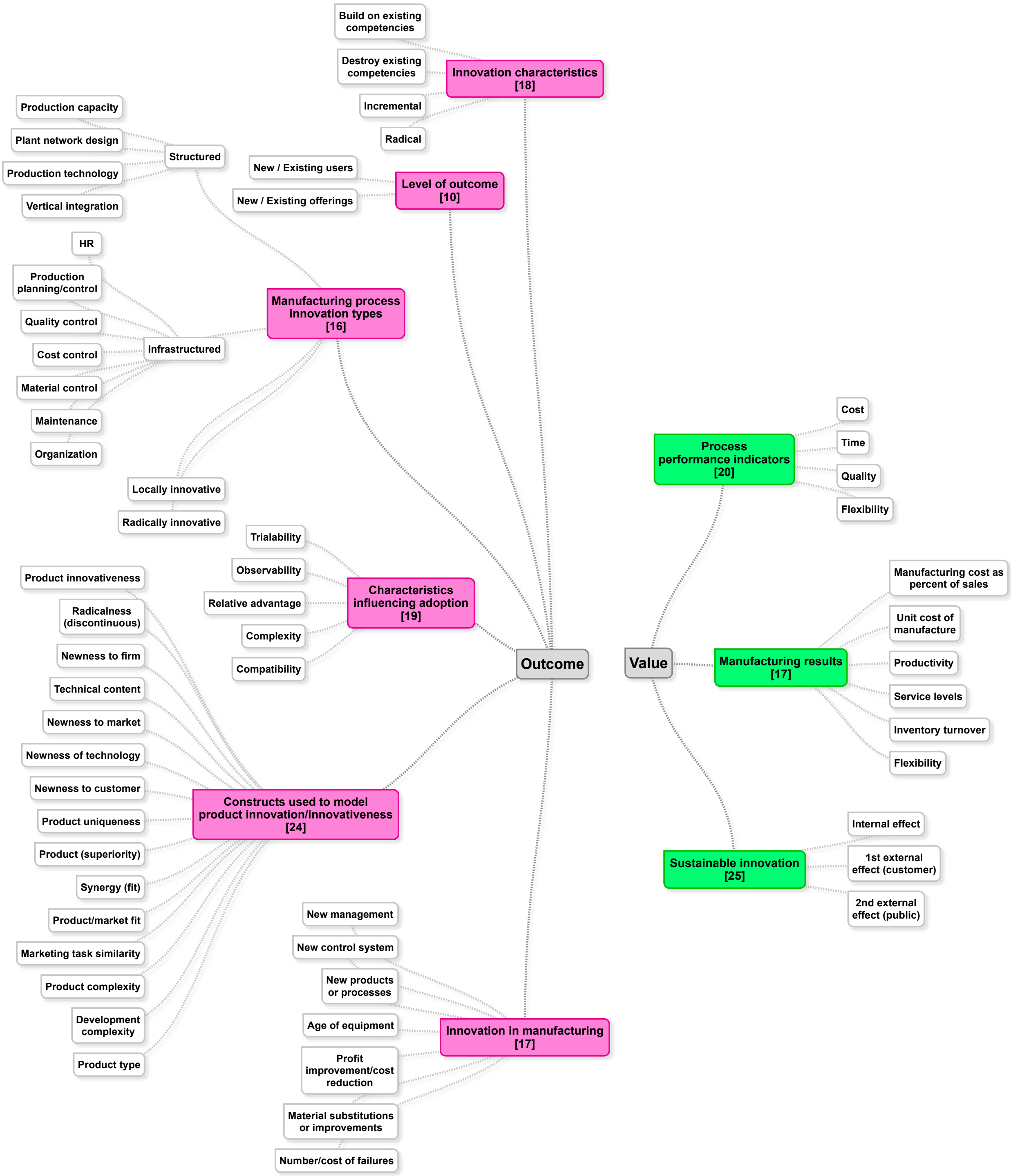
Fig. 5. Potential for implementation (1=Do not agree, 7=Fully agree), n=35.

5. Concluding remarks and future work

The initial testing of the assessment tool in 30 R&I projects in Produktion2030 show that this tool is a useful help in highlighting and assessing production innovation with its main constituting parts; novelty, value creation and implementation, and also exemplifies what production innovation is about. The types of outcomes chosen for the questionnaire seem to cover most outcomes from the projects, with only a few exceptions where comments were added from the respondents, and the same goes for value creation parameters. The implementation potential section also addresses an important part of innovation which is sometimes not considered to the same extent as the other; novelty and value creation. The different sections of the assessment tool function both as assessment of a project's (expected and actual) results e.g. for project selection and prioritization, but also as a learning opportunity. By realizing strengths and weaknesses in a project, efforts can be directed to fulfilling the important aspects in realizing innovation; novelty, implementation, value creation. As the tool is based on self-assessment, it involves a risk of positive bias in the results. In using the assessment perspective of the tool, this risk needs to be considered like for most other input to the project selection and prioritization.

The assessment tool may need further development as production develops and changes in character and objectives. This especially concerns the categorization of outcomes and value creation parameters as these are selected based upon the current situation and the future in sight. Moreover, although the tool is designed to be simple and easy to use, this also implicates a very selective content. Therefore, it could also be interesting to incorporate more aspects and details in the tool to try out and see how far this could be stretched without losing the desired ease of use.

Appendix A. Literature overview - assessment of innovation outcome and value



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