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MODELING AND OPTIMIZATION OF FLEXIBLE JOB SHOP SCHEDULING PROBLEMS – BASICS OF SELECTED RESEARCH TOPIC

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Abstract

The main aim behind my research is proper and effective planning of scheduling stage of an effective production planning and control of practical industries so that the whole production cost could be planned and managed in effective manner so the profit ratio of an industry could be increased irrespective of its earlier financial year. Before completion of the above mentioned aim we first identify the research and research category for a production planning and control of an industry. So firstly we firstly read the research and different research methodologies for production planning and control and thereafter we study the production planning and control alongwith their categories.

Keywords: Research, Research Methodologies, Production Planning and Control, Industrial Scheduling, Production Cost, Profit Ratio

INTRODUCTION TO RESEARCH

Research comprises "creative and systematic work undertaken to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications"[12]. It is used to establish or confirm facts, reaffirm the results of previous work, solve new or existing problems, support theorems, or develop new theories. A research project may also be an expansion on past work in the field. Research projects can be used to develop further knowledge on a topic, or in the example of a school research project, they can be used to further a student's research prowess to prepare them for future jobs or reports. To test the validity of instruments, procedures, or experiments, research may replicate elements of prior projects or the project as a whole. The primary purposes of basic research are documentation, discovery, interpretation or the research and development (R&D) of methods and systems for the advancement of human knowledge. Approaches to research depend on epistemologies, which vary considerably both within and between humanities and sciences [2]. There are several forms of research: scientific, humanities, artistic, economical social, business, marketing, practitioner research, life, technological, etc.

The word *research* is derived from the Middle French "*recherche*", which means "to go about seeking", the term itself being derived from the Old French term "*recerchier*" a compound word from "re-" + "cerchier", or "sercher", meaning 'search'.[1] The earliest recorded use of the term was in 1577. [1]

Research has been defined in a number of different ways.

A broad definition of research is given by Godwin Colibao: "In the broadest sense of the word, the definition of research includes any gathering of data, information, and facts for the advancement of knowledge."[14]

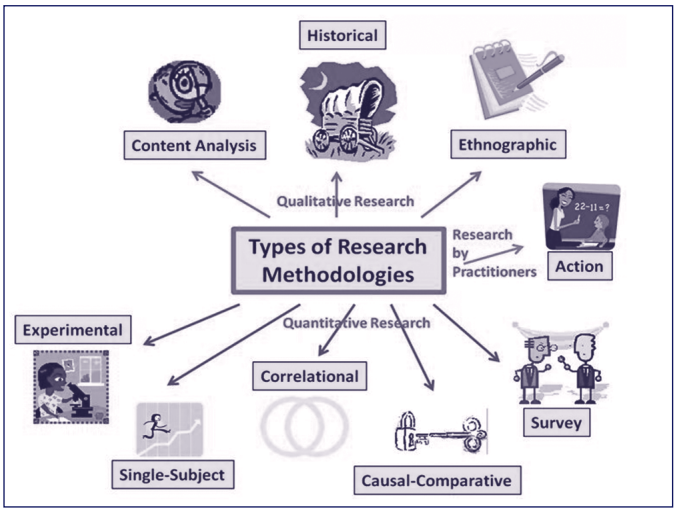
Another definition of research is given by John W. Creswell, who states that "research is a process of steps used to collect and analyze information to increase our understanding of a topic or issue". It consists of three steps: pose a question, collect data to answer the question, and present an answer to the question.[6]

The Merriam-Webster Online Dictionary defines research in more detail as "a studious inquiry or examination; especially investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws".[1]

BROAD CLASSIFICATION OF RESEARCH METHODS

Types of research methods can be broadly divided into two quantitative and qualitative categories. Quantitative research "describes, infers, and resolves problems using numbers. Emphasis is placed on the collection of numerical data, the summary of those data and the drawing of inferences from the data" [8].

Fig. 1. Types of Research Methodologies



Qualitative research, on the other hand, is based on words, feelings, emotions, sounds and other non numerical and unquantifiable elements. It has been noted that "information is considered qualitative in nature if it cannot be analyzed by means of mathematical techniques. This characteristic may also mean that an incident does not take place often enough to allow reliable data to be collected" [9].

QUANTITATIVE RESEARCH

This research is based on numeric figures or numbers. Quantitative research aims to measure the quantity or amount and compares it with past records and tries to project for future period. In social sciences, "quantitative research refers to the systematic empirical investigation of quantitative properties and phenomena and their relationships". The objective of quantitative research is to develop and employ mathematical models, theories or hypothesis pertaining to phenomena. The process of measurement is central to quantitative research because it provides fundamental connection between empirical observation and mathematical expression of quantitative relationships. Statistics is the most widely used branch of mathematics in quantitative research. Statistical methods are used extensively with in fields such as economics and commerce. In sum, the research using the normative approach conducts why may be called quantitative research as the inferences from it are largely based on quantitative data. Moreover, objectivity is the primary guard so that the research may be replicated by others, if necessary.

QUALITATIVE RESEARCH

Qualitative research presents non quantitative type of analysis. Qualitative research is collecting, analyzing and interpreting data by observing what people do and say. Qualitative research refers to the meanings, definitions, characteristics, symbols, metaphors, and description of things. Qualitative research is much more subjective and uses very different methods of collecting information, mainly individual, in-depth interviews and focus groups.

The nature of this type of research is exploratory and open ended. Small numbers of people are interviewed in depth and or a relatively small number of focus groups are conducted. Qualitative research can be further classified in the following type.

I. ***Phenomenology****:* a form of research in which the researcher attempts to understand how one or more individuals experience a phenomenon. E.g.: we might interview 20 victims of a tragedy.

II. ***Ethnography****:* this type of research focuses on describing the culture of a group of people. A culture is the shared attributes, values, norms, practices, language, and material things of a group of people. E.g.: the researcher might decide to go and live with the tribal in Andaman Island and study the culture and the educational practices.

III. ***Case study****:* is a form of qualitative research that is focused on providing a detailed account of one or more cases. E.g.: we may study a classroom that was given a new curriculum for technology use.

IV. ***Grounded theory****:* it is an inductive type of research, based or grounded in the observations of data from which it was developed; it uses a variety of data sources, including quantitative data, review of records, interviews, observation and surveys.

V. ***Historical research****:* it allows one to discuss past and present events in the context of the present condition, and allows one to reflect and provide possible answers to current issues and problems. E.g.: the lending pattern of business in the 19th century.

In addition to the above, we also have the descriptive research. This is the Fundamental research, of which this is based on establishing various research theories.

Also the research is classified into:

1. Descriptive research
2. Analytical research
3. Fundamental research
4. Conceptual research
5. Empirical research
6. One time research or longitudinal research
7. Fieldsetting research or laboratory research or simulation research
8. Clinical or diagnostic research
9. Exploratory research
10. Historical research
11. Conclusion oriented research
12. Case study research
13. Short term research

BASIC CLASSIFICATION OF RESEARCH METHODS

Research can be classified in many different ways on the basis of the nature and methodology of research, the knowledge it creates, the user group, the research problem it investigates etc.

Types of Research Methods according to Nature of the Study*:*

Types of the research methods according to the nature of research can be divided into two groups: descriptive and analytical.

- *Descriptive research* usually involves surveys and studies that aim to identify the facts. In other words, descriptive research mainly deals with the "description of the state of affairs as it is at present" [11], and there is no control over variables in descriptive research.
- *Analytical research*, on the other hand, is fundamentally different in a way that "the researcher has to use facts or information already available and analyse these in order to make a critical evaluation of the material". [11]

Types of Research Methods according to the Purpose of the Study*:*

According to the purpose of the study, types of research

methods can be divided into two categories: applied research and fundamental research. Applied research is also referred to as an action research, and the fundamental research is sometimes called basic or pure research.

- ***Applied Research***

  Applied research is designed to solve practical problems of the modern world, rather than to acquire knowledge for knowledge's sake. The goal of applied research is to improve the human condition. It focuses on analysis and solving social and real life problems. This research is generally conducted on a large scale basis and is expensive. As such, it is often conducted with the support of some financing agency like the national government, public corporation, World Bank, UNICEF, UGC etc. According to Hunt, "applied research is an investigation for ways of using scientific knowledge to solve practical problems" for example: improve agriculture crop production, treat or cure a specific disease, improve the energy efficiency of homes, offices, how can communication among workers in large companies be improved.

- ***Fundamental/Basic/Pure Research***

  This research is conducted largely for the enhancement of knowledge, and is research which does not have immediate commercial potential. The research is done for human welfare, animal welfare and plant kingdom welfare. It is called basic, pure, fundamental research. The main motivation here is to expand man's knowledge, not to create or invent something. According to Travers, "Basic Research is designed to add to an organized body of scientific knowledge and does not necessarily produce results of immediate practical value." Such a research is time and cost intensive. (Example: An experimental research that may not be or will be helpful in the human progress.)

  The table below summarizes the main differences between applied research and fundamental research [16]. Similarities between applied and fundamental (basic) research relate to the adoption of a systematic and scientific procedure to conduct the study [3].

Table 1. Difference between Applied Research and Fundamental Research

Applied Research	Fundamental Research
Tries to eliminate the theory by adding to the basics of a discipline.	Aims to solve a problem by adding to the field of application of a discipline.
Problems are analyzed from the point of one discipline.	Often several disciplines work together for solving the problem.
Generalizations are preferred.	Often researches individual cases without the aim to generalize.
Forecasting approach is implemented.	Aims to say how things can be changed.
Assumes that other variables do not change.	Acknowledges that other variables are constant by changing.
Reports are compiled in a language of technical language of discipline.	Reports are compiled in a common language

Types of Research Methods according to Research Design

On the basis of research design the types of research methods can be divided into two groups – exploratory and conclusive. Exploratory studies only aim to explore the research area and they do not attempt to offer final and conclusive answers to research questions. Conclusive studies, on the contrary, aim to provide final and conclusive answers to research questions. Table below illustrates the main differences between exploratory and conclusive research designs:

Table 2. Difference between Exploratory and Conclusive Research Design

	Exploratory Research	Conclusive Research
Structure	Loosely structured in design	Well structured and systematic in design
Methodology	Are flexible and investigative in methodology	Have a formal and definitive methodology that needs to be followed and tested
Hypotheses	Do not involve testing of hypotheses	Most conclusive researches are carried out to test the formulated hypotheses
Findings	Findings might be topic specific and might not have much relevance outside of researcher's domain	Findings are significant as they have a theoretical or applied implication

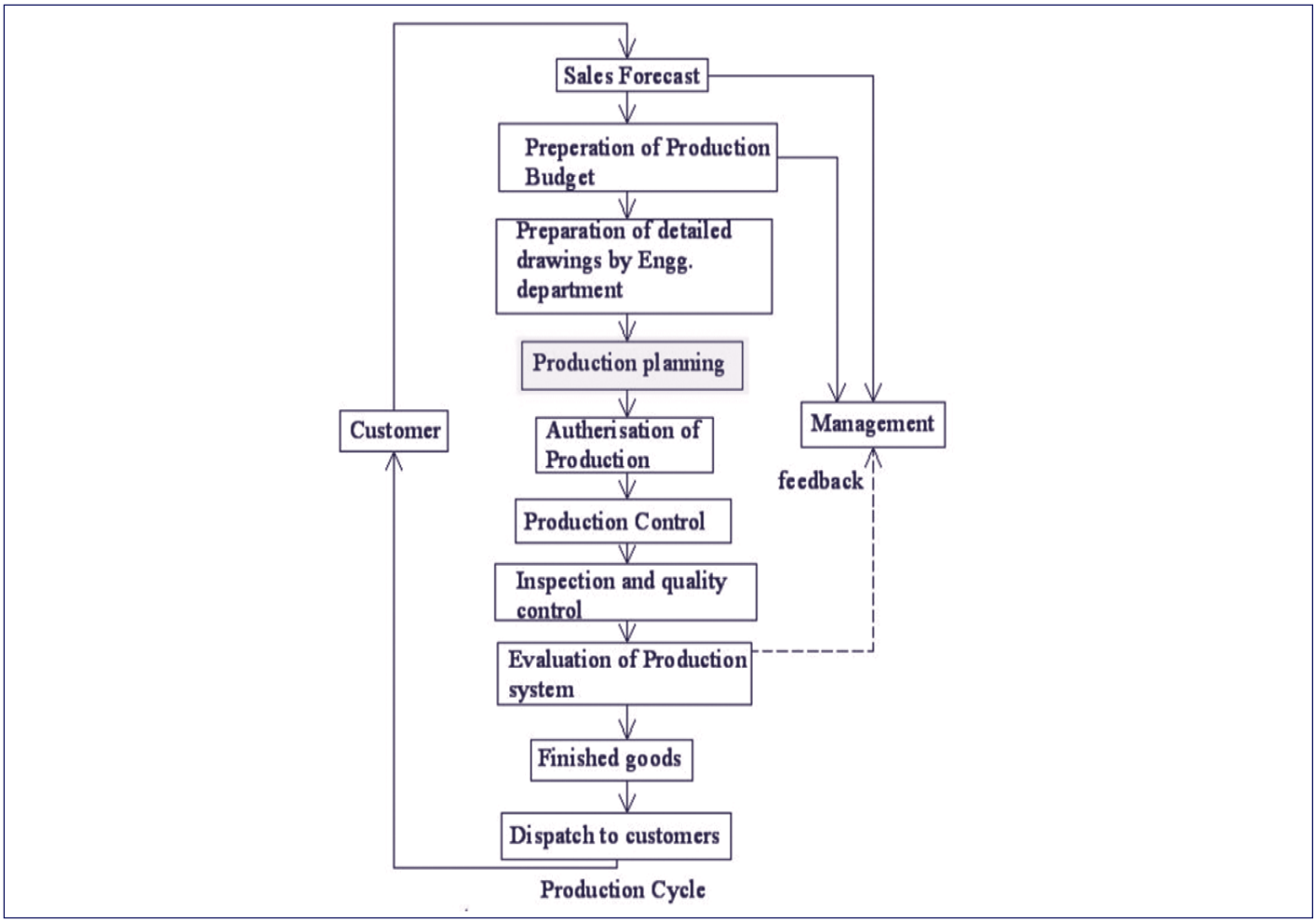
PRODUCTION PLANNING AND CONTROL

Production Planning

Production planning is the planning of production and manufacturing modules in a company or industry. It utilizes the resource allocation of activities of employees, materials and production capacity, in order to serve different customers. [7] Different types of production methods, such as single item manufacturing, batch production, mass production, continuous production etc. have their own type of production planning.

Production planning can be combined with production control into production planning and control, or it can be combined and or integrated into enterprise resource planning. Production planning is used in companies in several different industries [17], including agriculture, industry, amusement industry, etc.

Fig. 2. Production Planning and Production Control



It can comprise the following activities:

- Determination of the required product mix and factory load to satisfy customer's needs. [10]
- Matching the required level of production to the existing resources. [5]
- Scheduling and choosing the actual work to be started in the manufacturing facility" [7]
- Setting up and delivering production orders to production facilities. [4]

Types of Production Planning

Different types of production planning can be applied:

- Advanced planning and scheduling
- Capacity planning
- Master production schedule
- Material requirements planning
- MRP II
- Scheduling
- Workflow

Related kind of planning in organizations

- Employee scheduling
- Enterprise resource planning
- Inventory control
- Product planning
- Project planning
- Process planning, redirects to Computer-aided process planning
- Sales and operations planning
- Strategy

In order to develop production plans, the production planner or production planning department needs to work closely together with the marketing department and sales department. They can provide sales forecasts, or a listing of customer orders."[13] A critical factor in production planning is "the accurate estimation of the productive capacity of available resources, yet this is one of the most difficult tasks to perform well". [15] Production planning should always take "into account material availability, resource availability and knowledge of future demand".[4]

Production Control

Production control is the activity of controlling the workflow in the production. It is partly complementary to production planning.

The basic and practical knowledge of Production Planning and Control activities, it comes under both two quantitative and qualitative categories of broad research methodology

as Production Planning utilizes the resource allocation of activities of employees, materials and production capacity and Production control is the activity of controlling the workflow in the production, in order to serve different customers in effective, satisfactory manner for profit of the company/industry.

SCHEDULING (TABLE 3)

- Scheduling deals with the efficient allocation of tasks over resources.
- The general scheduling problem is, given a number of tasks and a number of resources, set the dates when each task should be accomplished on each resource.
- Scheduling is concerned with the assignment of time to set of jobs for processing through a group of machines in order to best satisfy some criteria.

Table 3. Scheduling Horizon applicable in a Company/ Industry

Level	Examples of Problems	Horizon
Long Range Planning	Plant Expansion, Plant Layout, Plant Design	2-5 Years
Middle Range Planning	Production smoothing, Logistics	1-2 Years
Short Range Planning	Requirement plan, Shop bidding, Due date setting	3-6 Months
Scheduling	Job shop routing, Assembly line balancing, Process batch sizing	2-6 Weeks
Reactive Scheduling / Control	Hot jobs, Down machines, Late material	1-3 Days

OBJECTIVES OF A GOOD SCHEDULING

- It is very difficult to find a good objective or a good formulation in a scheduling problem.
- It is difficult to quantify important objectives such as customer satisfaction with quality.

There are quite different objectives in scheduling

- Maximize shop throughput
- Satisfy customer desires for quality and promptness
- Minimize current out-of pocket costs.

CHARACTERISTICS OF A GOOD & SOLID SCHEDULE

The characteristics of a good and solid schedule indicate that it is:

- A Complete Schedule;
- A Full Term Schedule;
- Meets the Contractual Requirements / Milestones;
- Indicative of How the Project Will Be Built in the Field;

and that:

- Activity Durations are Reasonable;
- Activity Relationships are all defined;
- The Critical Path Makes Sense;
- It considers Procurement, Material and Equipment Deliveries;
- It is Resource Loaded

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