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Adapting the Approach of 'Management by Projects' in the Manufacturing Industry: A Conceptual Framework

Dr. Romil S. Al-Adwan

Assistant Professor
Department of Mechanical & Industrial Engineering,
Applied Science Private University, Amman, Jordan.

Abstract

Time and quality are the two most important elements in the development of new products in the manufacturing industry. This study examined the applicability of time and quality tools and techniques (used in project management) on the manufacturing projects.

Data was collected through a qualitative research methodology using a well-designed questionnaire was used to collect data from three different case studies. The case studies represent different type of manufacturers in Jordan.

The study demonstrated that manufacturing activities can be treated as manufacturing projects, provided that resources allocated for these projects are kept in tight control. A conceptual framework was developed that could benefit the manufacturing industry during the planning stage of the new product development. It also demonstrated that production schedule and quality of products can be improved when tools and techniques used in project management are used in manufacturing projects. Furthermore, this study developed a conceptual framework that explains how the manufacturing industry could benefit from treating manufacturing activities as manufacturing projects and apply on them tools and techniques used in project management.

Keywords: Project Management, Management by Projects, New Product Development, Stage-Gate Model

INTRODUCTION

Project Management (PM) is a system that was, originally, designed to help construction industry control the work scope, time, and cost of large projects. Other industries, such as Information Technology (IT), started applying PM in their projects and was found to be most effective. Most recently, other industries, such as manufacturing, are seemed to be convinced of the suitability of applying the tools and techniques of PM to their manufacturing projects.

The two most important factors in manufacturing, according to experts, are ***time*** and ***quality***. These two factors can be decisive in the success or failure of any product. PM uses certain tools and techniques to manage schedule and quality for different types of products in different industries.

Even though manufacturing consists of operational work, it can still benefit from PM tools and techniques. After all, producing a single product/service is the result of many projects put together. The basic idea here is to divide operational process into manageable projects. This paper investigates how tools and techniques of project time and quality management be best applied to improve the manufacturing processes through the New Development Products (NPD) Stage-Gate Model (SGM).

RESEARCH AIM AND QUESTIONS

This study aims to investigate how tools and techniques of project time and quality management be best applied to improve the manufacturing processes through the New Development Products (NPD) Stage-Gate Model (SGM). The study attempts to answer the following questions:

RQ1: Can manufacturing activities be treated as manufacturing projects?

RQ2: How can the manufacturing industry benefit from introducing the project time and quality management tools and techniques?

LITERATURE REVIEW

Project vs. Operation

Work performed by any organization is classified as either an *Operation* or a *Project*. Projects and operations have similarities and differences. For instance, operations need *Business Process Management*, while projects need *Project Management*. Furthermore, processes used in manufacturing are '*continuous*' while processes used in projects are '*temporary*'. A project is intended for the delivery of a unique product or service, while an operation (as in the case of the manufacturing industry) is intended to produce the same product or service, continuously. Having mentioned that, it may be assumed that Project Management tools and techniques are still used in the manufacturing process to ensure that certain schedules and quality of products are met.

According to PMI (2013), a project is defined as '*a temporary endeavor undertaken to create a unique product, service, or result*'. As the definition implies, a project is temporary (i.e. has a beginning and end) and delivers a product or service, whether tangible or intangible. The use of projects in managing a business is increasingly becoming an important factor in the success of the business (Hudson and Cicmil, 2006).

Since projects are part of almost all industries, such as IT, construction, and manufacturing, managing projects the correct way becomes very essential. PM has a central role to play in the management of almost all business activities in any organization (Aubry et al., 2008). Project Management is defined by PMI (2013) as '*the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements'*.

One of the main goals of PM is to balance between the project constraints (namely: scope, time, cost, and quality). If a change occurs in one variable (say, Scope), the other variables will be impacted. So, defining the scope, estimating the cost, allocating resources, and controlling quality are considered easy when dealing with a single project at the time. The problem starts to appear on the surface when having to deal with multiple simultaneous projects where resources are needed to be shared.

Tools and Techniques in Project Time Management

Mudrack (1997) defined time management, simply, as '*techniques for managing time'*. According to Claessens (2005), time management is '*behaviors that aim at achieving an effective use of time while performing certain goal-directed activities*'.

PMI (2013) provides a detailed model of the management of time in projects. It describes it through six different processes; '*Define Activities, Sequence Activities, Estimate Activity Resources, Estimate Activity Durations, Develop Schedule, and Control Schedule*' (Figure 1).

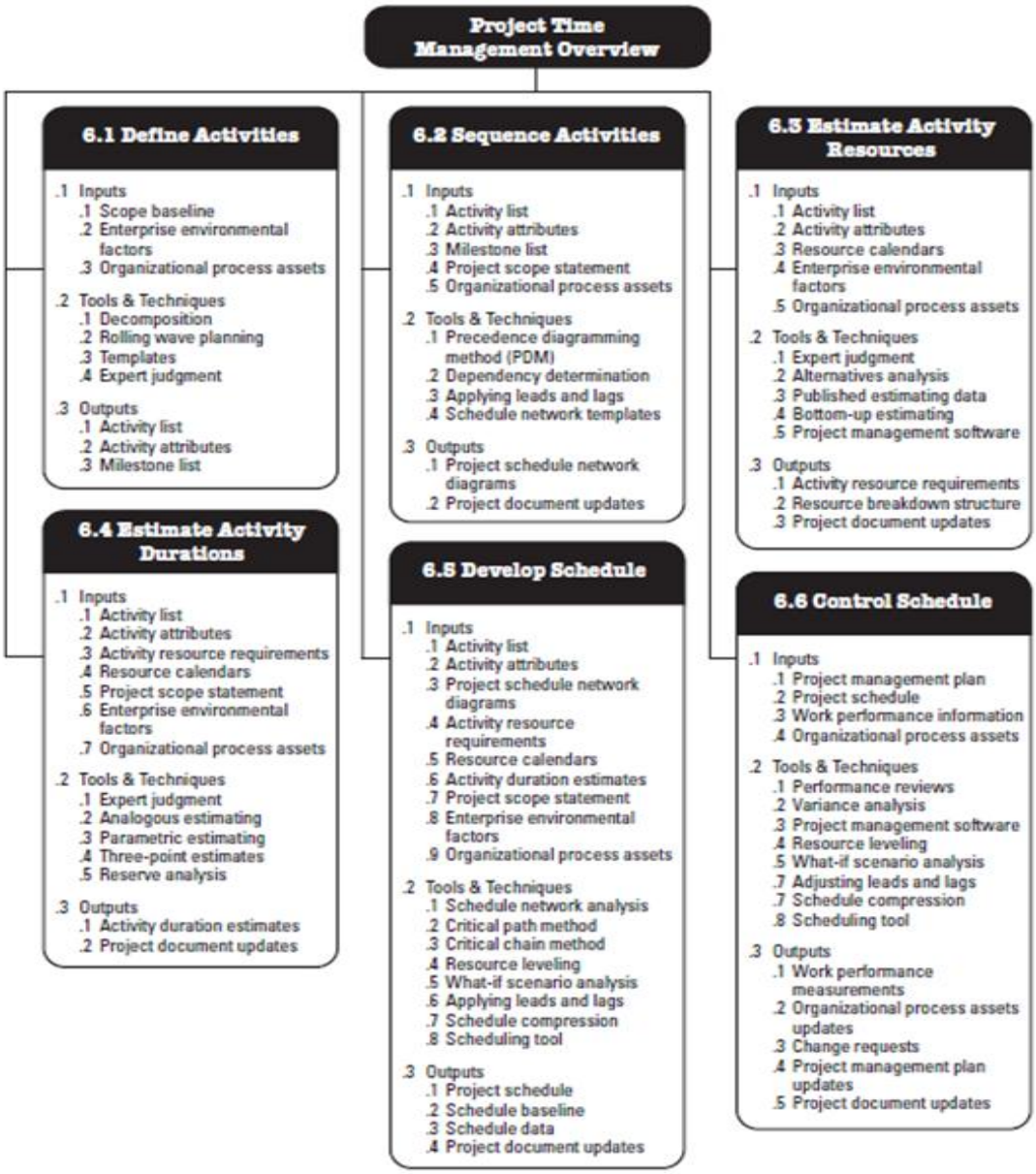

Figure 1: Project Time Management Overview

The manufacturing industry has its own operational processes and for sure uses its own tools and techniques. The researcher selected (based on PMI, 2013) some of the most used tools and techniques in Project Time Management, and they are:

Decomposition **-** a technique used for dividing and subdividing the project scope and project deliverables into smaller, more manageable parts.

Expert Judgment - a judgment provided based upon expertise in an application area, knowledge area, discipline, industry, etc., as appropriate for the activity being performed.

Precedence Diagramming Method (PDM) **-** a technique used for constructing a schedule model in which activities are represented by nodes and are graphically linked by one or more logical relationships to show the sequence in which the activities are to be performed.

Leads and Lags - the amount of time whereby a successor activity can be advanced with respect to a predecessor activity (Lead), and the amount of time whereby a successor activity is required to be delayed with respect to a predecessor activity (Lag).

Bottom-Up Estimating **-** a method of estimating project duration or cost by aggregating the estimates of the lower-level components of the work breakdown structure (WBS).

Analogous Estimating **-** a technique for estimating the duration or cost of an activity or a project using historical data from a similar activity or project.

Parametric Estimating **-** an estimating technique in which an algorithm is used to calculate cost or duration based on historical data and project parameters.

Three-Point Estimate **-** a technique used to estimate cost or duration by applying an average of optimistic, pessimistic, and most likely estimates when there is uncertainty with the individual activity estimates.

Group Decision-Making Techniques **-** techniques to assess multiple alternatives that will be used to generate, classify, and prioritize product requirements. Example: Brainstorming and Delphi techniques.

Critical Path Method **-** a method used to estimate the minimum project duration and determine the amount of scheduling flexibility on the logical network paths within the schedule model.

Critical Chain Method **-** a schedule method that allows the project team to place buffers on any project schedule path to account for limited resources and project uncertainties.

Resource Optimization Techniques **-** a technique that is used to adjust the start and finish dates of activities that adjust planned resource use to be equal to or less than resource availability. Example: Resource Leveling and Resource Smoothing.

> ***Resource Leveling*** **-** a technique in which start and finish dates are adjusted based on resource constraints with the goal of balancing demand for resources with the available supply.
>
> ***Resource Smoothing*** **-** a technique which adjusts the activities of a schedule model such that the requirement for resources on the project do not exceed certain predefined resource limits.

Modeling Techniques - Techniques used in the final planning process under Schedule Management. Example: Monte-Carlo Analysis.

> **Monte Carlo Simulation -** a process which generates hundreds or thousands of probable performance outcomes based on probability distributions for cost and schedule on individual tasks. The outcomes are then used to generate a probability distribution for the project as a whole.

Schedule Compression - Techniques used to shorten the schedule duration without reducing the project scope. Example: Crashing and Fast Tracking.

> **Crashing -** a technique used to shorten the schedule duration for the least incremental cost by adding resources.
>
> **Fast Tracking -** a schedule compression technique in which activities or phases normally done in sequence are performed in parallel for at least a portion of their duration.

Performance Reviews **-** a technique that is used to measure, compare, and analyze actual performance of work in progress on the project against the baseline. Example: Earned Value Management.

> **Earned Value Management -** a methodology that combines scope, schedule, and resource measurements to assess project performance and progress.

Tools and Techniques in Project Quality Management

According to the PMI (2013), quality is *'the degree to which a set of inherent characteristics fulfill requirements'.* Flood, (1993) defined quality as '*meeting the customer's requirements, formal and informal, at the lowest cost, first time, every time'*. Quality is one of the big concerns in manufacturing projects. When managing quality, project managers' main goal is concentrated on making sure that products meet the specifications that are supposed to meet, which are based on thorough planning and close consultation with all stakeholders.

According to PMI (2013) model, Project Quality Management consists of three major processes: *Plan Quality Management, Perform Quality Assurance*, and *Control Quality* (Figure 2).

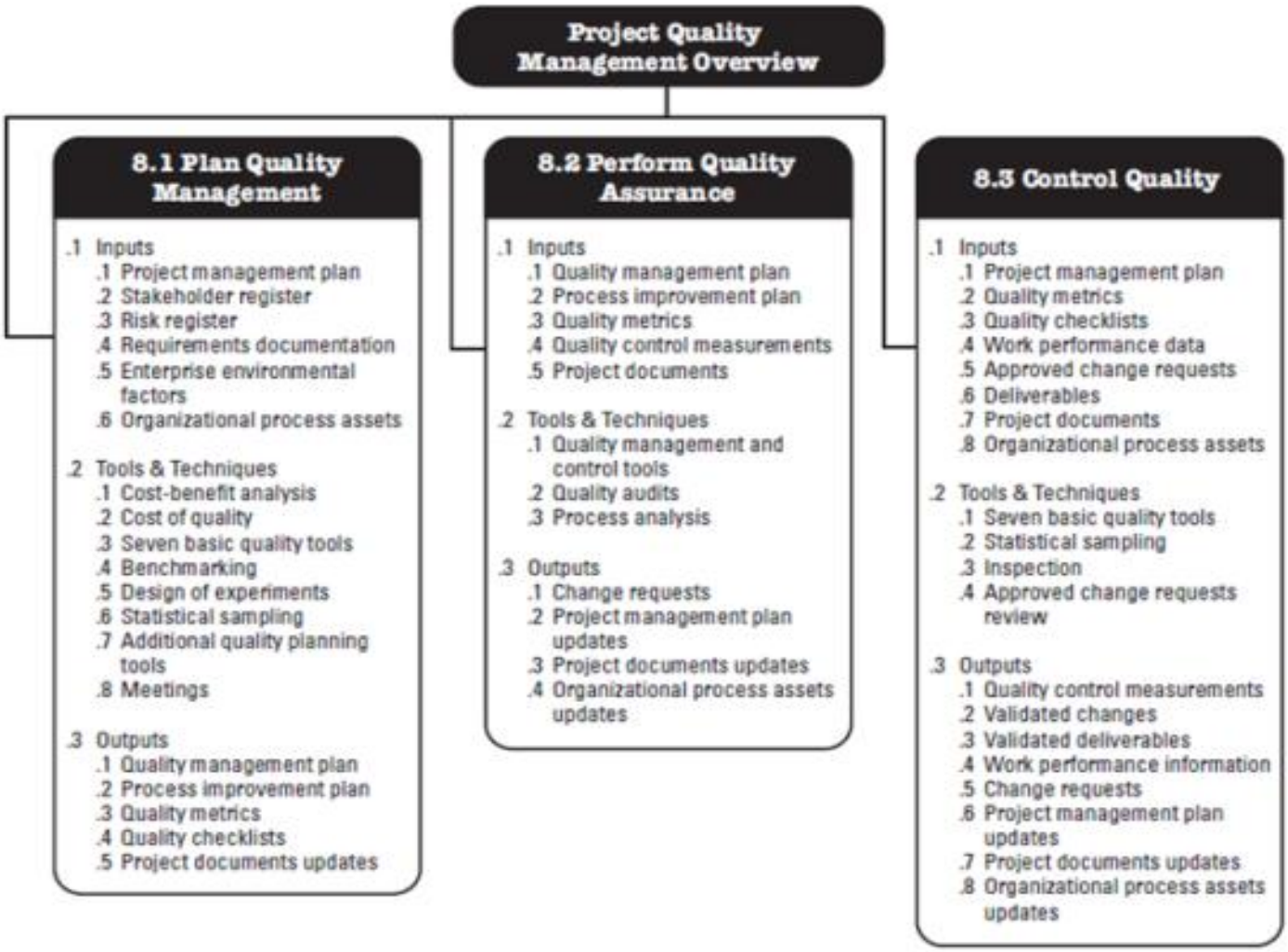

Figure 2: Project Quality Management Overview

According to (PMI, 2013) model, some of the most used tools and techniques, in Project Quality Management, are:

Cost-Benefit Analysis **-** a financial analysis tool used to determine the benefits provided by a project against its costs.

Seven Basic Quality Tools **-** a standard toolkit used by quality management professionals who are responsible for planning, monitoring, and controlling the issues related to quality in an organization. Cause and Effect Diagram, Control Charts, Flowcharting, Histogram, Pareto Chart, and Scatter Diagram.

Benchmarking **-** the comparison of actual or planned practices, such as processes and operations, to those of comparable organizations to identify best practices, generate ideas for improvement, and provide a basis for measuring performance.

Statistical Sampling **-** choosing part of a population of interest for inspection.

Quality Management and Control Tools **-** they are a type of quality planning tools used to link and sequence the activities identified.

Quality Audits **-** a quality audit is a structured, independent process to determine if project activities comply with organizational and project policies, processes, and procedures.

Management by Projects

Operation-based industries such as aerospace and shipbuilding have adapted project-based production in their business (Levering et al., 2013). The idea of dividing operations work into projects could be a practical and effective way forward in the on-going enhancement process in these industries, including manufacturing. This brings the idea of *Management by Projects*, or projectizing the business.

The manufacturing environment includes operation activities and project activities. It is important to recognize that projects and operations complete each other, in such environments, and need to work together aiming for better results. *Management by Projects* allows us to manage both categories of work as projects. According to PMI (2013),

'*The term Project Management is sometimes used to describe an organizational approach to the management of ongoing*

operations. This approach, more properly called Management by Projects, treats many aspects of ongoing operations as projects in order to apply project management to them'. (PMI, 2013)

Boznak (1996) argues that

'Project Management versus Management by Projects is not merely a twist on words … there is a significant difference in concepts, scopes and capabilities. Success in a Management by Projects environment requires a far different approach than merely applying more of the same Project Management systems and methods'. (Boznak, 1996)

One of the differences between *Project Management* and *Management by Projects* is that Management by Projects is more related with what can be accomplished given the available resources, while the Project Management's goal is concentrated to fulfilling the project goal. Management by Projects treats operational activities as projects.

Management by Projects implies the change of the Organizational Structure from Functional (departmental) to Matrix. This type of organization structure provides flexibility when it comes to dealing with the operational activities as projects. According to PMI (2013), '*Organizational structure is an enterprise environmental factor, which can affect the availability of resources and influence how projects are conducted'*. Organizational structures range from functional to projectized, as illustrated in Figure 3.

One obvious advantage of adopting the approach of *Management by Projects* is that measuring the various elements of a project becomes easy when the tools and techniques used in the ten Knowledge Areas used in Project Management. For the purpose of this study, only Time and Quality will be studied as they are the most important factors in the manufacturing industry. One good application of Management by Projects in the manufacturing industry is the customer support, where each case is treated as a separate project. Another example is the Ad Hoc (unplanned) manufacturing activities or services can be also treated as projects. Management by Projects could be implemented on all the activities (planned or unplanned) within the organization. It is a way of conducting business.

New Product Development

There are many product development models used in different studies. One of these models is the '*Stage-Gate Model'* by Cooper (1994). This model is one of the most popular models of New Product Development (NPD) (Figure 4). According to Cooper (1990), a typical NPD Stage-Gate Model consists of either four, five, six, or seven stages.

Organization Structure / Project Characteristics	Functional	Matrix			Projectized
		Weak Matrix	Balanced Matrix	Strong Matrix	
Project Manager's Authority	Little or None	Low	Low to Moderate	Moderate to High	High to Almost Total
Resource Availability	Little or None	Low	Low to Moderate	Moderate to High	High to Almost Total
Who manages the project budget	Functional Manager	Functional Manager	Mixed	Project Manager	Project Manager
Project Manager's Role	Part-time	Part-time	Full-time	Full-time	Full-time
Project Management Administrative Staff	Part-time	Part-time	Part-time	Full-time	Full-time

Figure 3: Organizational Structure (PMI, 2013)

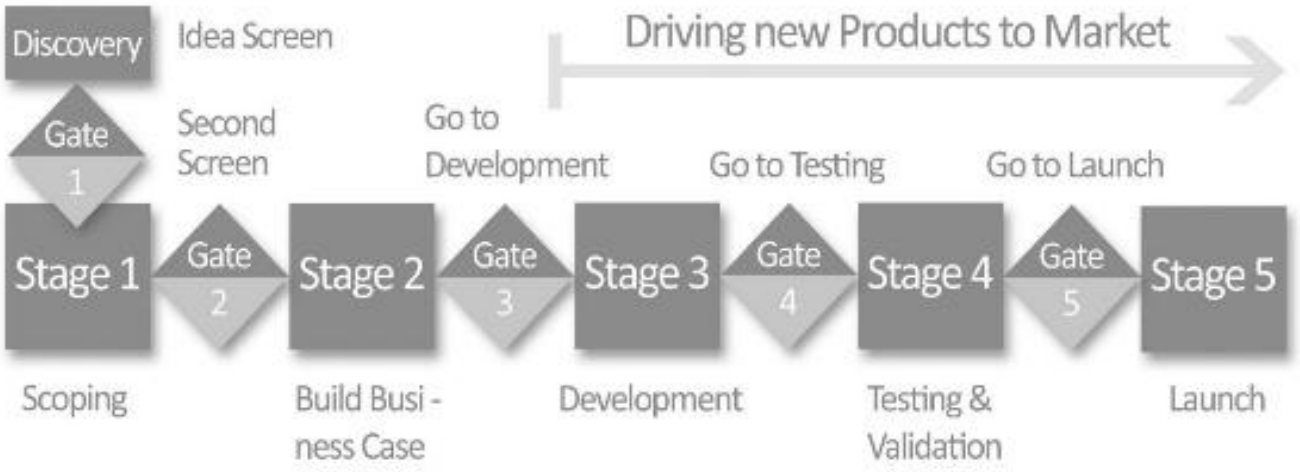

Figure 4: Stage-Gate Model (Cooper, 1994)

According to Cooper (1994), the Stage-Gate Model consists of:

Stage 0 (Discovery) - activities designed to discover opportunities and to generate new ideas

Stage 1 (Scoping)- a quick and inexpensive assessment of market, technology, and business

Stage 2 (Build Business Case) - a feasibility study that includes product and project definitions, project justification, and project plan

Stage 3 (Development) - this stage includes the actual design and development of the new product, operations plan, and test plans

Stage 4 (Testing and Validation) - it provides the validation of the product, manufacturing process, customer acceptance, and economics of the project

Stage 5 (Launch) - it includes beginning of full production and commercial launch

RESEARCH DESIGN

The Case Study

The Case Study approach was adopted in this study because it concentrates on studying a phenomenon in its natural settings. The researcher decided to consider three different companies who manufacture three different products: canned food, clothes, and wooden furniture. The three selected manufacturers are private medium-size companies, and have been in the market, in Jordan, for the past 20 years.

The Generation of Hypotheses

Based on the previous literature, the next step is to propose a framework and generate a set of hypotheses that explains the idea of adopting '*Management by Projects'* approach in the manufacturing industry:

H1*: Converting manufacturing activities into consecutive manufacturing projects impacts manufacturing time and quality positively*

H2*: The applicability of 'Management by Projects' approach impacts manufacturing project time and quality positively*

H3*: Applying Project Time Management tools such as Decomposition, Critical Path Method, & Brainstorming impacts manufacturing project schedule positively*

H4*: Applying Project Quality Management tools such as Statistical Sampling, Quality Audits, & Benchmarking impacts manufacturing project quality positively*

H5*: Adopting the Project Based Organization (PBO) structure impacts management of manufacturing projects positively*

H6*: Adopting the Project Management Office (PMO) approach impacts management of manufacturing projects positively*

H7*: The use of the New Product Development (NPD) model as a base for the management of the manufacturing projects impacts the whole process positively*

Data Collection

The qualitative research approach using a questionnaire and face-to-face semi-structured interviews was adopted. Ten individuals from both medium and executive managerial levels, at the three companies, have accepted to participate in the study, distributed as follows:

1st Company (Case Study A): 4 individuals (Vice President, General Manager, & two Engineers)

2nd Company (Case Study B): 3 Individuals (General Manger, & two Engineers)

3rd Company (Case Study C): 3 Individuals (three Production Engineers)

DATA ANALYSIS

Data was collected from ten participants representing three case studies, and summarized in Table 1, below.

Table 1: Summary of Data Collected

Hypothesis	SA	A	N	D	SD
H1	**4**	**3**	**0**	**2**	**1**
H2	**3**	**5**	**0**	**1**	**1**
H3	**2**	**5**	**1**	**2**	**0**
H4	**2**	**6**	**1**	**1**	**0**
H5	2	5	2	1	0
H6	3	6	1	0	0
H7	2	6	2	0	0

Key to Table 1 ⇨ **SA**: Strongly Agree, **A**: Agree, **N**: Neutral, **D**: Disagree, **SD**: Strongly Disagree

The relatively high percentage (70%) of the participants *agreed* and *strongly agreed* with the 1st hypothesis is an indication that management, within these organization, recognizes the importance of dividing operations activities into consecutive projects. When testing the 2nd hypothesis, a higher percentage (80%) *agreed* and *strongly agreed* that the approach of 'Management by Projects' may be used to manage these separate and consecutive projects.

As discussed in the literature review, time and quality are more important, in production, than other factors. The participants of this study recorded 70% and 80%, respectively, of *agreement* and *strong agreement* with the 3rd and 4th hypotheses. Participants believed that using project time and quality tools and techniques will contribute to the success of the manufacturing process. 70% of the respondents *agreed* and *strongly agreed* that if the approach of 'Management by Projects' to be implemented, the structure of the organization has to be changed to accommodate the new way of doing business.

When asked about the benefits of using a PMO, participants responded with 90% *agreement* and *strong agreement* that PMO would benefit the management of these projects. The participant recorded an 80% *agreement* and *strong agreement* to the idea of converting all activities, based on a NPD model, to projects.

The Conceptual Framework

Based upon the results of the data analysis, the following framework was developed (Figure 5). The conceptual framework consists of three elements: Stage-Gate Model for New Product Development (NPD), Project Time Management Processes, & Project Quality Management Processes. The Stage-Gate model is divided into six stages (Stage 0 through Stage 5) and five gates. The framework treats every single manufacturing activity within these stages as a project. Based on the structure of the NPD model, these projects are consecutive, meaning they follow each other when it comes to execution. For example, the activities '*Discover Opportunities'* and '*Generate New Ideas'* are two important activities, in Stage 1, who become two projects. When applying tools and techniques used in Project Time and Quality Management to these projects, schedule and quality will improve. Whatever applies to the Stage 1 projects applies to the other projects in the rest of the stages in the NPD model.

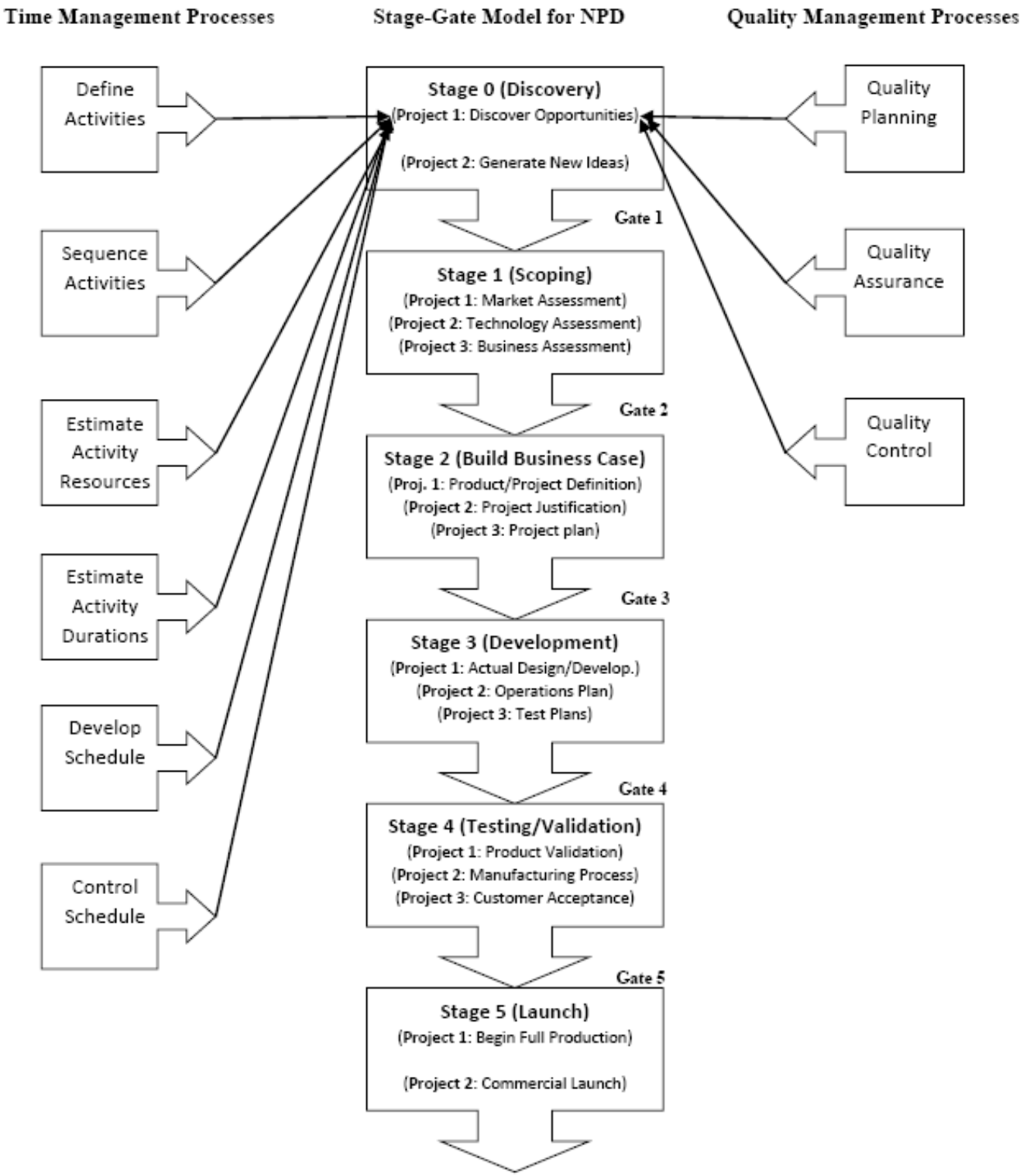

Figure 5: Conceptual Framework: Applicability of PM Time & Quality Tools & Techniques on New Product Development (NPD) Stage-Gate Model

DISCUSSIONS AND CONCLUSIONS

Based upon the data analysis, there is a need to establish a PBO in the manufacturing industry. This implies a change in the organizational structure to deal with the converted of manufacturing processes into projects. One good and practical way of getting the most benefit from PBOs is the establishment of a Project Management Office (PMO). According to Jerbrant (2013), the main goal of establishing a PMO is '*to increase the number of successful projects and to standardize the performance of the individual projects as much as possible'*.

Many studies deal with managing standalone projects. Dealing with a single project is relatively easy when it is compared to multi and consecutive projects. A manufacturing organization, once it converts its manufacturing process into a number of consecutive projects, has to take into account the expected challenges in having to deal with these projects simultaneously, in terms of the availability of resources. The complexity comes from the fact that these projects depend on each other and usually complex (Arvidsson, 2009). For these reasons, the planning stage is crucial, especially in defining and sequencing activities, estimating activities' resources and durations. One useful strategy of managing a multi-project environment is the adoption of Program Management or Portfolio Management (McDonough and Spital, 2003).

It can be concluded that manufacturing activities can be treated as manufacturing projects, provided that resources allocated for these projects are kept in tight control (through a PMO) to ensure successful, smooth, and continuity of production. The results of the data analysis demonstrated that the medium and executive level of management (at least in the three study cases in this research) is convinced that production schedule and quality of products can be improved when tools and techniques used in project management are used in manufacturing projects. This study provided a conceptual framework that explains how the manufacturing industry could benefit from treating manufacturing activities as manufacturing projects and apply on them tools and techniques used in project management.

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