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Key Factors to Increasing Free Cash Flow for Manufacturers Utilizing Lean Production: An AHP-DEMATEL Approach

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Abstract: This paper aims to apply AHP and DEMATEL to analyze the key factors and interrelationships of lean production to increase free cash flow for manufacturers. The AHP hierarchy was determined through literature and interviews with leading management experts. The assessment criteria were categorized into five major criteria and 15 sub-criteria, including production, sales, human resources, R&D, and finance. According to the AHP results, the first eight key factors were identified as the key factors to increasing cash flow for manufacturers who utilized lean production. DEMATEL was used to identify the interactions among the eight key factors and further identify the four more important ones. The four key factors are strategic planning, strategic deployment, leadership, and goal orientation. This paper proposes management implications and improvement suggestions for the four key factors and their interactions.

Keywords: *Lean Manufacturing, Key factors, Free cash flow, AHP, DEMATEL.*

1. Introduction

The concept of free cash flow was first introduced by Jensen in 1986 and is defined as the excess of protected assets and cash needed to finance new investments (Jensen, 1986, Richardson, 2006). Whether a company is healthy can be seen from the free cash flow (Oktariyani & Hasanah, 2019). Financial competitiveness is an extension of the core competitiveness theory from a financial perspective (Liu, Yu, Zhang, Xu, & Jin, 2021). The relationship between free cash flow and profitability is positively significant. A surge in free cash flow leads to a relative increase in the firm's profitability, which can be achieved through investment. There is a positive correlation between free cash flow and the profitability of listed companies (Hubbard, 1998, Afiezan, Wijaya, Priscilia, & Claudia, 2020). Managers can contribute to the company's growth through the free cash flow they are allowed to enter into the production of new products or services, as well as investments with positive net present value, relying on the company to implement lean manufacturing to reduce costs and generate profits (Mulugeta, 2021).

Management accounting consists of cost accounting (ABC) and production accounting, where "cost" is defined as the cost of resources used to produce products or services and sales (Al-Dhubaibi, 2021). The main advantage of this calculation method is that it allows controlling costs by comparing standard and actual values of calculations and reacting quickly and taking action in the production phase (Zaika & Vylegzhanina, 2017). Costs are closely related to production efficiency and can lead to significant company profitability and performance with more free cash flow; finance managers and operations managers need to consider management accounting for management (Ribalko, Varlamova & Yevtushenko, 2021). Lapsley and Rekers (2017) conclude that for management accountants to play a role in strategy formulation, they need to go beyond the boundaries of the accounting function and interact or communicate with individuals from other functions and companies in the supply chain. Cash flows received from operating activities, product sales, engineering results, services, and the related net income are the main conditions.

To ensure the flow of funds and the continuity of economic activities (Soboleva, Matveev, Ilminskaya, Efimenko, Rezvyakova & Mazur, 2018). The integration of 4.0 with business has influenced accounting science, cost accounting, and management accounting (Kablan, 2020). Taylor, the father of scientific management, introduced "The Principles of Scientific Management" (Jacobs, Chase & Aquilano, 2004) in the last century, which has evolved into today's issues of organizational division of labor, traditionally based on business functions (production management, marketing management, human resources management, and lean talents). The traditional division of labor according to corporate functions (production management, marketing management, human resource management, research and development, financial management)

(Jacobs, Chase & Aquilano, 2004; Fang, Tsai, Tsai, 2019). Since many assessment components and structural criteria are key factors in the study of lean management for growing free cash flow (FCF).

Such as production management, marketing management, and other related assessment criteria, cover a wide range of levels and are complex in scope, and fall under the scope of Multi-criteria Decision-making (MCDM). The Analytic Hierarchy Process (AHP) is a systematic approach to complex problems, which is suitable for decision-making problems with multiple attributes in uncertain situations (Saaty, 1988). However, the interactions are uncertain, so this paper uses DEMATEL to explain the interactions and dependencies (Kilic, Yurdaer & Aglan, 2021; Mubarik, Kazmi & Zaman, 2021). This study was conducted to answer the above key factors of growth free cash flow (FCF) and to introduce a set of criteria for evaluating growth FCF by using AHP-DEMATEL to investigate the proportion of key factors of growth FCF, their relative importance, and their interactions and dependencies.

This study collected domestic and international academic literature on the factors influencing corporate functions. We then used expert interviews to obtain the appropriate assessment constructs and criteria for this study on corporate functions. In general, the purpose of this study is to use the AHP-DEMATEL computational model and the empirical study of lean factory operations to evaluate the key indicators of each function and their interactions and dependencies to increase the cash flow of the enterprise. This research framework is divided into five sections. Aside from this first section, the second section reviews the literature and the development of the management function evaluation criteria and the influencing factors, the third section introduces the AHP and DEMATEL research methods, the fourth section conducts the empirical analysis, and the fifth section presents the conclusions and recommendations as to the final chapter.

2. Literature Review

Taylor, the father of scientific management, introduced The Principles of Scientific Management in the last century. Lean Manufacturing/Management (LM) is a philosophy that involves the use of a set of tools in operational processes to optimize people, time, assets, and productivity while maintaining the quality of products and services as a competitive advantage for business entities to improve competitive performance (Ibrahim, 2021). LM is a philosophy that involves using a set of tools in the operational process to optimize people, time, assets, and productivity while maintaining the quality of products and services, a competitive advantage for business entities to improve their competitive performance (Ibrahim, 2021). These factors were analyzed to understand the financial competitiveness of Indian automobile companies: asset utilization, cost-effectiveness, market value, foreign trade, liquidity, market value, productivity, profitability, solvency, value-added performance, and working capital efficiency. Using factor analysis, financial competitiveness was measured using 13 indicators such as cash flow capability, development capability, operational capability, profitability, and solvency (Liu, Yu, Zhang, Xu, & Jin, 2021). The corporate functions include the division of labor in the areas of operation management, marketing management, human resource management (lean talents), R&D (lean Kaizen R&D), and financial management (Fang, Tsai, & Tsai, 2019).

Operation Management: Operations management is a very important part of management today, especially in industrial enterprises (Touriki, Benkhati, Kamble & Belhadi, 2021). Many organizations conduct strategic planning to systematically assess and evaluate their current state, establish or update their mission and objectives, and identify strategies and activities to achieve their goals (Harvey, Gapstur, Pottinger, Elena & Helzlsouer, 2021). Strategic planning (SP) impacts business development and performance (Al-Qershi, 2021). It is a formal, ongoing process for setting goals and implementing actions to position the organization in the marketplace while matching available sources with market opportunities. Ultimately, a strategically oriented organization can connect the past with the present and anticipate the future, aligning its actions with the realities of the operating environment (Thomas, 2021). New Product Development (NPD) selects products based on a wide range of business and technical needs, followed by physical prototyping, testing and validation, volume production, and finally, product release (Ulrich & Eppinger, 2012). One of the basic conditions for the company's development and long-term success is innovation (Świąder & Marczewska 2021). NPD is based on customized modeling and programs supported by appropriate tools; therefore, it brings significant benefits in terms of production costs, product quality, and supply chain availability, which

are crucial for success, business development, and efficiency (Azanedo, Garcia-Garcia, Stone & Rahimifard, 2020). The function of quality assurance in the production process is to ensure that when errors and defects are detected in the production process, they are corrected in the production process as quickly as possible.

The correlation with production conditions is known from the analysis of poor quality, and the analysis of the problem can lead to corrective measures (Elkaseer, Mueller, Charles & Scholz, 2018, Samuel, Rajesh, Rajanna & Franklin, 2021). Using experimentally validated simulations, the process parameters are studied first, and the information is useful to significantly reduce the need for failure validation analysis after production (Dong, Liu, Wen, Ge, & Liang, 2019). This is what we call "built-in quality"; the quality elements faced during production are already taken into account in the product development process, and anti-defective measures are put in place to realize that quality is continuously established from product development to production. The quality mindset of the developers is an important key for the organization and the application of different quality methods and tools (Saleh, 2020). The Operations Manager is responsible for allocating departmental resources throughout the company to achieve profitable and efficient operations. By participating in meetings to provide strategic guidance to the organization, they work with plant quality managers to ensure that quality requirements align with market demands (Wolniak, 2019; Susilawati, 2021). We can define operations management as the fundamental role in the company is the transformation of inputs such as raw materials into finished products and services (Domingues & Machado, 2017, Fiorentino, 2016). The final realization of the operational function is responsible for producing products and providing services (Wolniak, 2019; Wolniak, Skotnicka-Zasadzień, Zasadzień, 2017).

Marketing Management: The beginning of business operations began with the Voice of the Customer, a term that emerged in (Griffin & Hauser, 1993). A customer-oriented approach is integral to corporate culture in the next generation of system standards. The customer-centric approach is a component of corporate culture, and in the new generation of system standards, the customer organization's customer-centricity is emphasized (Samuel, Rajesh, Rajanna & Franklin, 2021). There are different types of customers: new and unchanging, random and loyal, potential and followers, and each type of customer contributes differently to total revenue, but they are all equally important (Linde & Philippov, 2021). Quality Function Deployment (QFD) is the systematization of listening to the "voice of the customer" and translating customer needs through each stage of product development into products that meet customer requirements is a necessary condition; through QFD, We analyze customers' needs, make technical responses, make the supply sequence to the market the priority, train professionals in their respective positions, and improve the quality of human resources (Pandya, Ismoyowati & Suharno, S., 2020). The customers are concerned about quality, delivery, and price. Good quality depends on detailed SOPs to provide more consistent products and quality and better service (Samuel, Rajesh, Rajanna & Franklin, 2021). It is necessary to have an ongoing dialogue with customers on the subject of research and to inform them about how the findings will be used.

To improve the quality of product features or specific services (Linde & Philippov, 2021; Attaqwa, Saputra & Khamal, 2021). The Just in Time (JIT) supply chain has attracted increasing interest from operations management scholars (Tseng, Wee, Reong & Wu, 2019; Chung, Talluri, Kovács, 2018; Yao & Hsu, 2018). JIT provides companies with numerous advantages, including reduced costs, reduced inventory, improved product quality, shorter lead times, increased responsiveness, reduced waste, increased customer satisfaction, and superior competitive advantage (Heizer, Render & Munson, 2016; Mas'udin & Kamara, 2018; Dieste, Panizzolo & Garza-Reyes, 2021). Finally, the fulfillment of the promise to the customer, the customer value proposition (CVP) is a strategic tool that companies use to communicate how they aim to deliver value to their customers as one of the most widely used terms in business (Payne, Frow and Eggert, 2017; Hao, Liu & Goh, 2021). The concept of a quality-expanding CVP company should include listening to the customer, a just-in-time supply chain, full participation in the company products that satisfy the quality of the customer expectations finally meeting the promise of delivery to the customer (Becerra-Fernández, Herrera, Trejos, & Romero, 2021, Kim, Montreuil & Klibi, 2022). Hamadamin & Singh (2019) found that most respondents believe that marketing strategies to deliver on promises are key to the success of all companies and an important tool for increasing customer satisfaction (Kim, Montreuil & Klibi, 2022).

Lean Talents: Execution determines the success or failure of a company. The need for companies to transform to Industry 4.0 manufacturing, production, and operations management in a realistic manufacturing environment, especially in production planning, scheduling, execution, and control; and to achieve competitive advantage in cost, efficiency, and quality (Guo, Li, Zhong & Huang, 2021) is dependent on competent executives. The magic of a company's success is not in the philosophy, tools, and technology but rather in the people who perform (Karekatti, 2021). In a professional work environment, any education and improvement are about people because they are the ones who bring about the needed change by being the change agents (Gao, Wang, Wang, Ma & Li, 2022). Talent's echelon building (TEB) includes popularizing lean concepts and building a talent echelon pool. Talent development should focus on the process and the results expressed in performance; the process is the means, and performance metrics provide feedback to people (Jing, Tang & Yan, 2018). Talent acquisition is a strategic approach to identifying, attracting, and acquiring the best talent to effectively and efficiently meet dynamic business needs (Budianto, Surachman, Hadiwidjojo & Rofiaty, 2021). The implementation of TPS focuses on the manufacturing priorities of safety, quality, delivery, and cost. Unlike traditional manufacturing plants that start with cost reduction, TPS aims to increase efficiency and reduce costs by implementing JIT production and kanban control systems (Sugimori, Kusunoki, Cho & Uchikawa, 1977).

The goal of the lean enterprise is to improve the efficiency of the entire enterprise while providing the necessary quality and ideal personalized products to consumers in the shortest possible time (Palange & Dhatrak, 2021; Maware, Okwu & Adetunji, 2021). According to Henao, Sarache & Gómez (2019), adopting both JIT and Total Quality Management (TQM) requires social systems to develop skills and desired levels of worker participation to avoid harmful consequences to operational and safety performance. The combination of lean practices, JIT and TQM, improves operational performance by supporting goal-oriented practices that improve the ability to address changes that affect quality, delivery, flexibility, or cost. The main pillars in marketing content marketing (CM), including the relationship between content, customer engagement, and the enterprise's marketing objectives and their subfactors, are illustrated in this goal-oriented model (Yaghtin, Safarzadeh & Zand, 2020). It is important to continuously improve all business processes in a lean enterprise to avoid waste through strategic deployment (PD) matrix management. Therefore, process orientation should be based continuously and requires an integrated approach to collaborate in an evolving organization and its processes. The dynamic integration of all processes can be accomplished by applying strategic deployment (PD) matrix management (Mohanty & Pradhan, 2020; Womack & Jones, 1996). In addition to the above, the application of strategic deployment (PD) matrix management can also be used to integrate the organization and its processes.

Lean Kaizen R&D: The Japanese word KAIZEN stands for two levels: Kai for change and Zen for better, so Kaizen means "continuous improvement"; the KAIZEN approach is based on three pillars that are best suited for continuous improvement management, involving every process, function, and person in the company" (Kumar, Dhingra & Singh, 2018, Choudhary, Nayak, Dora, Mishra & Ghadge, 2019). Castillo (2022) states that the Lean production system (LPS) needs a tool called Value Stream Mapping VSM to evaluate its effectiveness in improving sustainable performance. There is an opportunity to use VSM to identify improvement points for waste and problems (Castillo, 2022). The practice of VSM management must break away from the traditional management structure and create a lean organization that comprehensively considers all processes throughout the value stream. Through this detailed process orientation, all participants in the entire value chain can be linked together. Traditional management will face a major challenge because traditional rigid organizations cannot communicate correctly and quickly through all value processes (Mohanty & Pradhan, 2020). In short, the overall structure needs to be aligned with the company's cultural, ecological, and social goals (Hernandez-Matias, Ocampo, Hidalgo & Vizan, 2020, Hernandez-Matias, Ocampo, Hidalgo & Vizan, 2020).

All organizations aim for success, and it is impossible to manage the lean level of the organization and grow free cash flow without measuring the organization's performance (Abreu & Calado, 2017). Achieving a lean transformation in an organization must begin at the leadership level to be successful (Netland, Powell & Hines, 2020). Senior executives motivate the entire workforce to participate and teach by example with their active participation in the improvement and work with employees to create systematic ways of working, presenting

lean transformation and continuous improvement (Antony & Gupta, 2019). There is a positive relationship between leadership development and operational performance, which should be interpreted as an incentive for managers when deciding whether to invest in developing the capacity to implement a lean production system (LPS) (Seidel, Saurin, Marodin & Ribeiro, 2017). Management commitment and engagement remain the most frequently cited critical success factors for Lean implementation in the literature (Antony & Gupta, 2019, Antony & Gupta, 2019). Leaders take the lead in encouraging shop floor workers to drive continuous Lean improvement, thus describing the importance of shop floor workers using the oft-quoted Toyota principle: "Before we build cars, we build people" (Ohno, 1988; Liker, 2004).

Lean management, also known as lean thinking or the Toyota Production System (TPS), is a production strategy developed by Taichi Ohno in the 1950s. The goal of lean management is a culture of continuous improvement through a requirement for production processes and procedures to improve by as little as 1% per day and a culture of operational excellence using standardization and oriented worker participation (Womack & Jones, 1996). Rapid Mass Engagement Process (RME), where employees are fully engaged, and task forces are formed to complete the improvement ideas provided by employees in a time-bound manner. Otherwise, it is just "pseudo-engagement" (Devine, 2016). Employee engagement and participation are fundamental to reaping the full benefits of TPS implementation (Liker, 2004). Vries and Poll (2018) found that the more progress is made in lean processes, the more engagement and participation there is, resulting in more teamwork. 15 of the 19 lean techniques have a very significant positive coefficient. People engage because they expect to have a better understanding and progress. They improve through 5-S and Kaizen team participation; the more they learn, the more they participate in team meetings.

Financial Management: Lean concepts have proven their effectiveness in improving the operational performance of companies, and lean programs can improve financial performance indicators. A bundle of JIT and TQM lean practices is recommended as the best enabler of financial performance in terms of sales and profitability, manufacturing and the operational and financial performance of the company (Kim, Montreuil & Klibi, 2022, (Dieste, Panizzolo & Garza-Reyes, 2021). Lean bundles (just-in-time, total quality management, and human resource management practices) and manufacturing servitization have independent and complementary effects on sustainable performance (Hao Liu & Goh, 2021). Since the 1960s, Japan has also proposed a system similar to the Balanced Scorecard BSC as a well-integrated system for deploying lean strategies. The system was named Hoshin Kanri (Policy Management HK) and has been implemented by companies worldwide as an important component of lean transformation strategies (Chiarini & Vagnoni, 2016; Vries and Poll, 2018). The company uses PD (strategic deployment) and DM (daily management), Quality Insurance (QI) stories, and simple Quality Control (QC) tools. The interdependencies between the functions of each project are mapped as part of the stakeholder management process, and relevant resources become part of the core project and support team. The team is asked to set stretch goals for each project as part of the vision of the World Class Organization (WCO), with the key tool being PD (Strategic Deployment) (Sachdev & Agrawal, 2017). In performance management, the Balanced Scorecard (BSC) has a key assumption that each performance measure is part of a balanced cause-effect relationship.

Where leading measures drive lagging measures. By tracking the company's progress against these measures, managers and employees can accomplish the company's mission by identifying and correcting underperforming perspectives (Kaplan & Norton, 1996). The Balanced Scorecard (BSC) is one of the most common financial management metrics used by small, medium, and large companies (Cooper, Ezzamel & Qu, 2017). It helps companies to measure the progress of their performance goals and to be able to make decisions and improvement plans regarding the company's strategies and activities (Susilawati, 2021). People are the company’s most important resource to accomplish financial management indicators. The strengthening of financial management combined with the most important competencies of business managers is the result of the strong reality of practical experience. Within the rule of thumb, the rise and improvement techniques of the manipulation and execution of people to the group and the enterprise. The primary goal in strategic monetary control is the rule of the organization manager, so the right to adopt the appropriate strategy during the most tolerable economic downturn and get the group into an emergency financial degree and prosperity throughout the danger depends on the executive power of managers (Kembauw, Munawar, Purwanto, Budiasih & Utami, 2020). Human resources are the study of people.

Employees are the assets of any company, and employees improve the efficiency and performance of the company; obtaining strategic human resources practices is essential to ensure that the organization's performance reaches its peak (Al-Khaled & Fenn, 2020, Al-Qershi, 2021).

Evaluation Criteria of Key Factors: The following table will use these five aspects of the study as a basis to further explain the criteria and increase the perspective of this paper. The following table summarizes the evaluation matrix, criteria and index descriptions, and references, as shown in Table 1.

Table 1: Key Factors to Increasing Free Cash Flow for Lean Production

Factors	Sub-Factors	Descriptions	References
A Operation Management	A_1 Strategic Planning	The organization conducts strategic planning through systematic evaluation, evaluates its current status, establishes or updates its mission and goals, and identifies strategies and activities to achieve the goals to improve the sustainable development and performance of the enterprise.	(Harvey, Gapstur, Pottinger, Elena & Helzlsouer, 2021), (Al-Qershi, 2021), (Thomas, 2021)
	A_2 New product planning	Innovative product design solutions are selected for the company's development and benefits, and products are released based on a wide range of business and technical requirements. This process brings significant benefits regarding production costs, product quality, and supply chain.	(Ulrich & Eppinger, 2012) ; (Świąder & Marczewska, 2021), (Azanedo, Garcia-Garcia, Stone & Rahimifard, 2020)
	A_3 Quality is built into the process.	The so-called "built-in quality" is the quality that is continuously established during the product development process. To prevent errors and defects in the production process, the three no's of quality are: Do not accept defective materials. Do not manufacture defective products. Do not deliver defective products. This ensures that no defective products are exported.	(Elkaseer, Mueller, Charles & Scholz, 2018), (Samuel, Rajesh, Rajanna & Franklin, 2021), (Saleh, 2020)
B Marketing Management	B_1 Quality first	Through QFD analysis techniques and consistent SOPs, training is conducted in respective positions to improve human resources, control process quality, and ensure product quality.	(Samuel, Rajesh, Rajanna & Franklin, 2021), (Pandya, Ismoyowati and Suharno, 2020), (Attaqwa, Saputra, & Khamal, 2021)
	B_2 Fulfill promise	A marketing strategy that delivers on its promise is key to the success of any business and is an important means of increasing customer satisfaction. The Customer Value Proposition (CVP) is a company's strategic tool to communicate value to its customers.	(Payne, Frow and Eggert, 2017); (Hao, Liu & Goh, 2021), (Becerra-Fernández, Herrera, Trejos & Romero, 2021); (Kim, Montreuil & Klibi, 2022)
	B_3 On-time delivery	The JIT supply chain provides companies with numerous advantages, including lower costs, lower inventories, higher product quality, shorter lead times, higher response times, higher customer satisfaction, and superior competitive advantages.	(Heizer, Render & Munson, 2016); (Dieste, Panizzolo & Garza-Reyes, 2021), (Tseng, Wee, Reong & Wu, 2019)

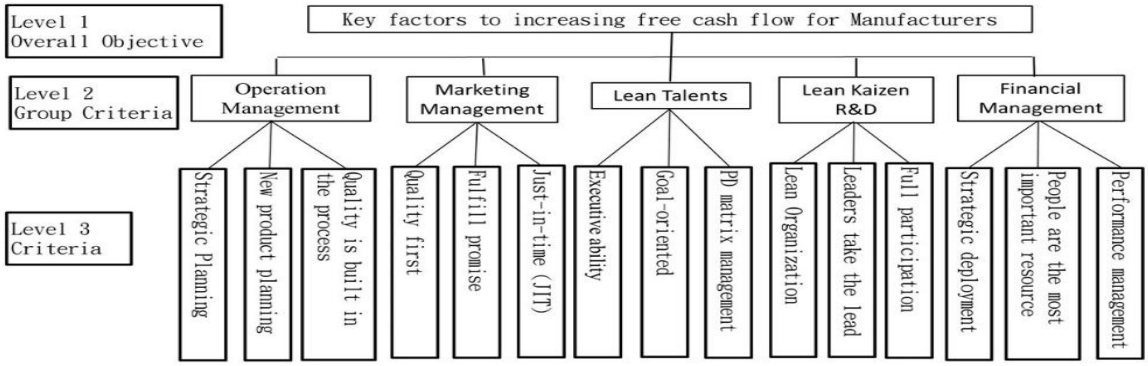
	C_1 Executive ability	Only with top-notch execution capabilities can we execute our strategy well. The magic of TPS's JIT production is not in the philosophy, tools, and technology but in the execution of the people involved. Management must share their passion for execution.	(Guo, Li, Zhong & Huang, 2021), (Karekatti, 2021)
C Lean Talents	C_2 Goal-oriented	The goal of the lean enterprise is to improve cost efficiency. Combining JIT and TQM to support goal-oriented practices improves the ability to address changes that affect quality, delivery, flexibility, or cost, thereby improving operational performance.	(Palange & Dhatrak, 2021). (Maware, Okwu, & Adetunji, 2021), (Henao, Sarache & Gómez, 2019)
	C_3 PD matrix management	Applying Strategic Deployment (PD) matrix management to accomplish organizational growth, you can clearly understand the 3-5 year plan, first-year goals and priorities, and who is responsible for completing improvements within the scheduled time frame.	(Mohanty & Pradhan, 2020); (Womack & Jones, 1996)
	D_1 Lean Organization	Creating a lean organization takes full account of all the processes in the entire value stream. All participants in the entire value chain can be linked together. The business structure of a lean organization includes a lean development system, a lean manufacturing system, lean sales and service system, and a lean leadership and culture.	(Mohanty & Pradhan, 2020), (Hernandez-Matias, Ocampo, Hidalgo & Vizan, 2020)
D Lean Kaizen R&D	D_2 Leaders take the lead.	Management commitment and engagement continue to be the most frequently cited critical success factors for Lean implementation in the literature. The goal of a Lean program is to lead leadership to instill a culture of continuous improvement in the organization so that the company becomes better every day. Successfully achieve Lean Transformation.	(Netland, Powell & Hines, 2020), (Antony & Gupta, 2019), (Ohno, 1988) ; (Liker, 2004)
	D_3 Full participation	The more employees are involved in the Lean process, the more progress will be made. Employee engagement is fundamental to a company's desire to improve efficiency and benefit from TPS implementation. Effective use of many TPS tools (such as eliminating the eight types of waste) generates more teamwork.	(Womack & Jones, 1996), (Devine, 2016), (Liker, 2004)
	E_1 Strategic deployment	The Hoshin Kanri (Policy Management-HK) process with policy deployment is an important component of developing a Lean transformation strategy. A lean team is established by top management to solve problems based on continuous improvement (CI), jointly set team goals, and practice organizational change management.	(Chiarini & Vagnoni, 2016), (Vries and Poll, 2018), (Sachdev & Agrawal, 2017)
E Financial Management	E_2 People are the most important resource.	People are the most important resource in a business because they are the core of any organization. It is vital to ensure that organizational performance is at its peak. The oft-quoted Toyota principle: "Before building cars, build people."	(Al-Khaled & Fenn, 2020), (Kembauw, Munawar, Purwanto, Budiasih & Utami, 2020)

E_3 Performance management	The Balanced Scorecard (BSC) framework comprises four perspectives - financial, customer, internal processes, and learning and growth. Based on Key Performance Indicators (KPIs), these balanced cause-and-effect measures are used to track the company's progress. Managers and employees can accomplish the company's mission by identifying and correcting underperforming perspectives.	(Kaplan & Norton, 1996). (Cooper, Ezzamel & Qu, 2017), (Susilawati, 2021)

3. Research Method

The AHP Technique: Since many evaluation structures and evaluation criteria are key factors to increasing free cash flow for manufacturers who apply them in a sophisticated manner, such as operations management and marketing management, they cover a wide range of levels and are complex in scope, and fall under the scope of Multi-criteria Decision-making (MCDM). The Analytic Hierarchy Process (AHP) is a method of systematizing complex problems, which is very suitable for decision-making problems with uncertainty and multiple attributes (Saaty, The Analytic Hierarchy Process, 1980). Therefore, this study is one of the main motives of this study to answer the above-mentioned free cash flow growth problems and to introduce a set of criteria for evaluating free cash flow growth to investigate the relative importance of the key factors of free cash flow growth for manufacturers who apply the lean operation, further to investigate the key factors of free cash flow growth. Figure 1 shows the hierarchical structure of the key factors for the success of free cash flow management at the lean operation level.

Figure 1: Hierarchical Structure



AHP [13] is an MCDM method proposed by Professor Thomas Saaty at the University of Pennsylvania in the 1970s and developed at the University of Pittsburgh in the 1980s (Saaty, The Analytic Hierarchy Process, 1980). Over the past 30-40 years, research using AHP has appeared frequently in academic journals. The method has been applied in many applications and d to management practices in many contexts. For example, AHP has been applied to environmental sustainability assessment (Zhang & Chen, 2017; Park, Lee & Lee, 2020), supplier selection (Nagy, Ruppert & Abonyi, 2020, Çalık, 2021), strategic planning assessment (Basset, Mohamed, Sangaiah & Jain, 2018, Chiarini, 2019), e-commerce (Rouyendegh, Topuz, Dag & Oztekin, 2019, Sun & Li, 2020), Internet of Things (IoT) (Durão, Carvalho & Takey, 2018, Mashal, Alsaryrah, Chung & Yuan, 2019), inventory management (Vergara, Sánchez, Poveda-Bautista & Diego-Mas, 2020; (Nariswari, Bamford & Dehe, 2019) and risk factor assessment (Tseng, Ding & Chen, 2018; Tseng, Wee, Reong & Wu, 2019).

The objective of the AHP method is to systematize complex questions by arranging the assessment dimensions of each question in a hierarchical framework and using the framework to distinguish different levels at which pairwise comparisons can be performed. In AHP, the factors and levels of analysis have the

following characteristics (Vargas, 1990): intercomparison, independence, homogeneity, and expectation. The structure of an MCDM problem usually consists of objectives, criteria/sub-criteria, and alternatives, and the number of levels depends on the problem's nature and the analysis's depth (Ding & Liang, 2004). According to (Saaty, The Analytic Hierarchy Process, 1980), the number of evaluation criteria to be matched at any level should not exceed seven. After all, levels have been constructed; the standards for each level must be compared to the standard or target level above as the assessment standard. If there are n standards, then n(n-1)/2 pairwise comparisons must be performed. Since pairwise comparisons constitute a valid cohesive judgment method, this study uses AHP to determine the relative weights of assessment criteria.

An AHP questionnaire is administered to assess the relative importance of factors affecting growth FCF for studying key growth FCF metrics for manufacturing companies that apply precision in ranking key growth FCF metrics. A hierarchical structure was constructed using five assessment dimensions and 15 evaluation criteria, as shown in Figure 1. In addition, Table 1 was also used to design the questionnaire to obtain the relative weights of all assessment dimensions and criteria. We invited experts with more than 15 years of experience in different manufacturing industries to complete an AHP expert questionnaire. The questionnaire survey period was three months. Of the 30 questionnaires distributed, five were not returned during the survey period, and 4 of the remaining 25 did not pass the consistency test. There were 21 valid questionnaires remaining (70% validity rate). The demographic profile of these experts is listed in Table 2.

We applied the operational steps of AHP, and the results of the 21 valid questionnaires were calculated in agreement with the two-comparison judgment. The consistency index (CI) and consistency ratio (CR) values were less than equal to 0.1 or less. Robbins (1994) suggests that 5-7 individuals are the optimal number of experts to participate in group decision-making. This suggests that the number of valid questionnaires in this study is representative of the results. In addition, the results of the eigenvalue, CI, and CR values of the 21 valid questionnaires are provided in this paper, as shown in Table 1. After coding the valid questionnaires and aggregating expert opinions, the operational steps of the AHP method were conducted to finally obtain the weights of the evaluation criteria at each level. These results provide an understanding of the relative importance of the evaluation dimensions and criteria.

Table 2: Demographic Profiles of Experts

Seniority	Position	Number of Experts	Industry
21 and above	General Manager, Deputy General Manager, Factory Manager, Director	9	Hand/power tools, auto parts, functional testing of board-level and finished products, non-standard automation equipment, high-speed rail brake systems, product testing instruments, management consulting, drill chucks, and power tool components.
16 ~20	General Manager, Director	4	Medical Equipment, Product Testing Instruments, Lean Consulting, Mechanical Equipment
11~15	Deputy General Manager, Factory Manager, Manager, Engineer	8	Auto parts, product testing instruments, office software

The DEMATEL Method: The Science and Human Affairs Program originally developed the Decision-making trial and evaluation laboratory (DEMATEL) method at the Bataille Memorial Institute in Geneva between 1972 and 1976 for the study and resolution of complex and intertwined problem clusters (Gabus & Fontela, 1972). The DEMATEL method improves the understanding of problem-specific, intertwined problem clusters and helps identify feasible solutions through hierarchical structures. Since the capabilities of DEMATEL complement AHP, their combination is quickly being used to solve practical management problems (Du & Li, 2021). Unlike traditional techniques such as AHP, which assume independent elements, this approach is one of the structural modeling techniques that can identify the interdependencies between system elements through causal graphs (Chiu, Hu, Lo & Chang, 2020). Causal graphs use numerical directional graphs rather than undirected graphs to describe the underlying concepts of contextual relationships and the strength of influence between elements (Dwijendra, Akhmadeev, Tumanov, Kosov, Shoar & Banaitis, 2021).

4. Results and Discussions

AHP Results: As can be seen from Table 3, the weights of the five-factor dimensions for growing free cash flow are, in order, "C_1- Operation Management (0.3221)", "C_3- Lean Talents (0.2053) ", "C_5- Financial Management (0.1817)", "C_2- Marketing Management (0.1527)", and "C_4- Lean Kaizen R&D (0.1382)". "Operation Management (C_1)" is the most important among them. Table 2 also shows the importance of the evaluation criteria under the five-factor dimensions is ranked as follows.
(1) In dimension "C_1", "Strategic Planning (C_{11})" is the most important evaluation criterion.
(2) In dimension "C_2", "Quality first (C_{21})" is the most important evaluation criterion.
(3) In dimension "C_3", "PD matrix management (C_{33})" is the most important evaluation criterion.
(4) In dimension "C_4", "Leaders take the lead (C_{42})" is the most important evaluation criterion.
(5) In dimension "C_5", "Strategic deployment (C_{51})" is the most important evaluation criterion.

Daniel (1961) argues that most companies have two to six factors that determine their success (Tuan, 2021), and if a company wants to be successful, it must strive for excellence in these factors. We assume that the weight of the key assessment criteria must be greater than the average weight of all assessment criteria (1/15 or 0.0667) to be selected as a meaningful key indicator. Accordingly, since the weight of the first eight criteria is greater than 0.0667 and the sum of these eight key criteria is 0.7038 (more than 70%), these eight criteria are selected as key growth FCF indicators for this study. The results of this study indicate that the eight most important key growth FCF indicators are "C_{11}", "C_{51}" with a subscript, "C_{13} ", "C_{12}", "C_{42}", "C_{33}", "C_{32} ", "C_{21}". These findings also indicate that the eight most important evaluation criteria are mainly under the "C_1" dimension and include "Strategic Planning (C_{11})", "Quality is built in the process (C_{13})," and "New product planning (C_{12})". In contrast, the "C_2" dimension only has a single key evaluation criterion, "Quality first (C_{21})", and the "C_3" dimension has "PD matrix management (C_{33})" and "Goal-oriented (C_{32})" are the two key evaluation criteria. The "C_4" dimension only has the key evaluation criterion "Leaders take the lead (C_{42})". For the "C_5" dimension, only "Strategic deployment (C_{51})" is this key evaluation criterion. In addition, among the eight key criteria, the first two indicators weigh nearly 0.1 and above, indicating that the first two key criteria are particularly important in the decision to grow free cash flow.

Table 3: AHP Weights of Factors

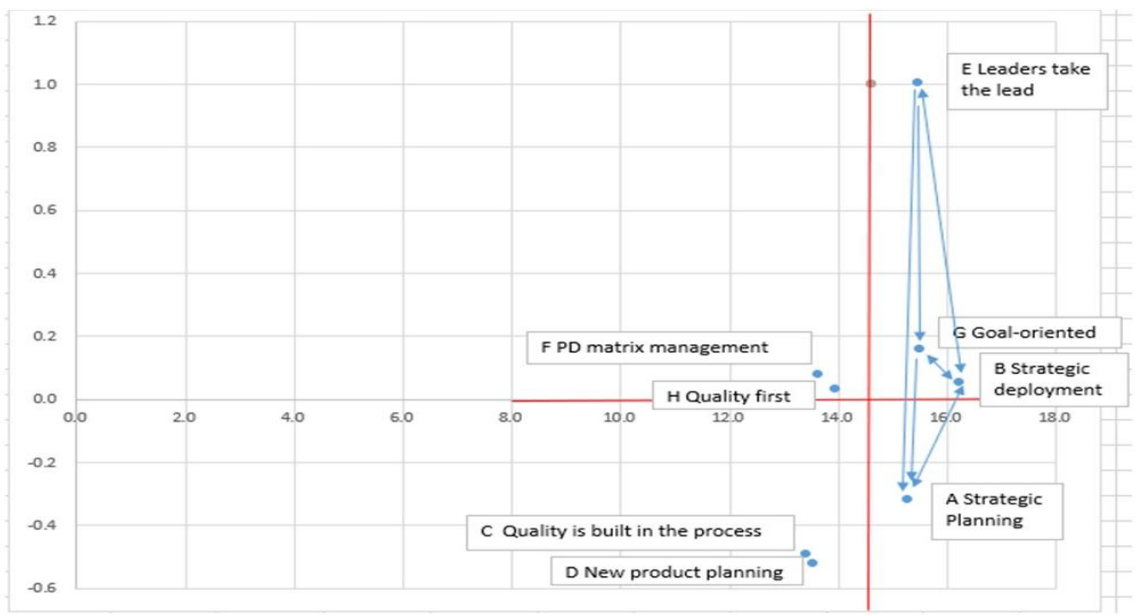
Factors	Weights (A)	Assessment Criteria	Weights (B)	Aggregate Weights (C) = (A) * (B)
Operation Management	0.3221 (1)	Strategic Planning	0.5171 (1)	0.1666 (1)
		New product planning	0.2377 (3)	0.0765 (4)
		Quality is built into the process	0.2452 (2)	0.0790 (3)
Marketing Management	0.1527 (4)	Quality first	0.4407 (1)	0.0673 (8)
		Fulfill promise	0.2514 (3)	0.0384 (13)
		Just-in-time (JIT)	0.3079 (2)	0.0470 (11)
Lean Talents	0.2053 (2)	Executive ability	0.3128 (3)	0.0642 (9)
		Goal-oriented	0.3432 (2)	0.0705 (7)
		PD matrix management	0.3440 (1)	0.0706 (6)
Lean Kaizen R&D	0.1382 (5)	Lean Organization	0.3210 (2)	0.0444 (12)
		Leaders take the lead	0.5469 (1)	0.0756 (5)
		Full participation	0.1321 (3)	0.0183 (15)
Financial Management	0.1817 (3)	Strategic deployment	0.5380 (1)	0.0978 (2)
		People are the most important resource	0.2988 (2)	0.0543 (10)
		Performance management	0.1631 (3)	0.0296 (14)

DEMATEL Results: The AHP results of this study show that the importance ranking is known, but their causal relationship with each other is unknown. The eight most important key growth FCF indicators were coded as "C_{11}=A", "C_{51}=B", "C_{13}=C", "C_{12}=D", "C_{42}=E", "C_{33}=F", and "C_{32}=F". "C_{12}=D", "C_{42}=E", "C_{33}=F", "C_{32}=G", " C_{21}=H". We used the above eight important indicators as the DEMATEL questionnaire and asked 21 experts with valid AHP questionnaires to answer the DEMATEL questionnaire again. Table 4 shows the total influence relationship matrix. The causal relationship diagram of the eight evaluation dimensions is shown in Figure 2.

Table 4-5: The Total Influence Relationship Matrix

	D	R	D+R	D-R
A	7.4680	7.7873	15.2553	-0.3193
B	8.1361	8.0821	16.2182	0.0539
C	6.4633	6.9551	13.4185	-0.4918
D	6.5003	7.0200	13.5203	-0.5197
E	8.2260	7.2210	15.4471	1.0050
F	6.8481	6.7686	13.6168	0.0795
G	7.8320	7.6735	15.5056	0.1585
H	6.9829	6.9490	13.9319	0.0339

Figure 2: The Causal Relationship Diagram of the Eight Factor Dimensions



From the DEMATEL matrix of interactions (Figure 2), four of the eight KPIs were found to be relatively independent of each other, namely "C=C_{13}=Quality is built in the process", " D=C_{12}=New product planning", "F=C_{33}=PD matrix management", and "H=C_{21}=Quality first ", while the remaining four have influence relationships. Three of them have mutual influence relationship, they are "B=C_{51}= Strategic deployment versus A=C_{11}= Strategic Planning", "B=C_{51}= Strategic deployment B=C_{51}= Strategic deployment versus E=C_{42}= Leaders take the lead" and "B=C_{51}= Strategic deployment versus G=C_{32}= Goal-oriented". Three other indicators influence other indicators are "E=C_{42}= Leaders take the lead has to influence on A=C_{11} Strategic Planning", "E=C_{42}= Leaders take the Leaders take the lead has an impact on G=C_{32}=Goal-oriented", "G=C_{32}=Goal-oriented has an impact on A=C_{11}= Strategic Planning".

Discussions: Daniel (1961) argued that most industries have two to six critical factors determining success. If a company is to be successful, it must do a particularly good job with these factors (Tuan, 2021). In the AHP study, among the eight key criteria, the first two indicators, Strategic Planning and Strategic Deployment have a weighting of nearly 0.1 and above, indicating that the first two are particularly important in the decision to grow free cash flow. In the DEMATEL study, the first two key indicators of AHP were also included in the four cause-effect relationships: 1. strategic deployment, 2. strategic planning, 3. leaders taking the lead, and 4. goal-oriented. The above findings show that the four key growth "free cash flow" metrics with causal influence and leadership include "Strategic deployment," "Strategic Planning," "Leaders take the lead," and "Goal-oriented." The following section discusses the four key metrics identified in this study, explains their practical implications, and provides recommendations for implementation.

(A) Strategic Deployment: From the DEMATEL cause-effect diagram, we understand that strategic deployment impacts the other three (KPI, leader, and goal). The deployment consists of strategic thinking, strategic planning, and strategic Innovation and uses limited human resources to implement long-term plans (Al-Qershi, 2021). We use breakthrough thinking to set three-year goals, break them down into yearly improvement plans, and execute them; we use strategic innovation to accelerate the development of new products and achieve the highest economic efficiency.

(B) Strategic Planning: KPI performance is influenced by leader and goal setting. Using the concept of the Balanced Scorecard (BSC) to transform business strategy into Key Performance Indicators (KPIs) by limiting the performance measurement tools of key objectives to ensure a balance between short-term performance measured by financial indicators and non-financial factors will lead the organization to achieve better competitiveness and long-term sustainability (Benková, Gallo, Balogová & Nemec, 2020). Performance index (KPI) is daily performance management that accumulates its short-term benefits into long-term results that affect Strategic deployment.

(C) Leaders Take the Lead: Leadership competency is positively correlated with key operational performance indicators, organizational lean maturity levels, and leaders' experience with lean systems (Seidel, Saurin, Marodin & Ribeiro, 2017). There is a positive relationship between leadership competency development and operational performance, with leaders influencing goal orientation and KPI results. This is complementary to Strategic deployment.

(D) Goal-Oriented: Goal orientation and strategic deployment influence each other, from strategic deployment to set goals. Challenging goal setting must be led by a good leader, both of which drive the efficiency of KPIs. Good goal setting has a mediating effect and helps the leader to accomplish the KPI, the baseline for measuring and improving the company's overall performance. Team cohesion towards the same goal, any team needs to be well connected with other teams, and knowledge needs to be exchanged between teams; therefore, a collective organizational vision is formed so that everyone works towards a common organizational goal and becomes a goal-oriented organization with team bridging (Vivas-López, 2014).

5. Conclusion and recommendations

This paper examines the important research issue of how manufacturers should collect a set of suitable assessment criteria for evaluating growth FCF proposals and identifying key growth FCF indicators. We use AHP and DEMATEL methods to investigate key growth FCF indicators for manufacturers. The initial set of significant influences, derived from a survey of case companies and expert interviews, consisted of five key assessment dimensions and 15 assessment criteria. Then, we conducted an empirical survey using AHP and DEMATEL expert questionnaires. Research findings reveal that "Financial Management" is a key evaluation dimension for assessing the growth of FCF programs. The four most important KPIs for Financial Management are "Strategic deployment (PD)," "Strategic Planning (KPI)," "Leaders take the lead," and "Goal-oriented." Based on the findings of these four key indicators, some practical recommendations are suggested. Firstly, strategic deployment (PD) is one of the two mega indicators of growth FCF and has the greatest impact. Therefore, we recommend that the company's senior management stay in close contact with the market to maintain proper target setting over the long term, grasp market changes, set a 3~5 year target,

think out-of-the-box, and use it as a long-term strategic deployment, then break down this target into annual sub-targets, and from the sub-targets, prioritize the important assessment sequence and set an action plan to accomplish the goal year by year.

For example, Tesla's electric car is a typical strategic deployment that subverts the concept of out-of-the-box thinking in the automotive industry by defining electric cars as a combination of Artificial Intelligence (AI) and machinery. Because of this breakthrough strategy, the final result is 1. A high-end AI threshold to enter the market; 2. A high-performance supercharged charging network and high-capacity batteries to reduce mileage concerns; 3. Advanced in-vehicle information services; and 4. vertical integration of charging networks, as strategic deployment has led to today's Tesla success story (Chen & Perez, 2018) Secondly, strategic planning (KPI) is another mega indicator in the growth of free cash flow; KPI short-term goals rely on daily management to achieve the indicator steadily. When the target is not achieved, root cause countermeasures (RCCM) must be activated to find the root cause using 5 WHY 1 HOW (5W1H) to return to the expected target quickly. Execute daily visual management Kanban, including S-Safety, Q-Quality, D-Delivery, I-Inventory, and P-Efficiency. For example, Toyota's TPM for equipment maintenance on its production line uses four Key Performers index (KPI) indicators, including 1. Personnel, 2. Methods, 3. Machinery and 4. Materials as the measurement mechanism for equipment reliability KPI (Sakai & Li, 2021). Thirdly, leaders should take the lead to engage all employees and understand the importance of Lean Manufacturing (LM) through a talent training program.

Leaders take the lead developed to lead the team to participate in the on-site improvement and solve problems by fact-based means. Develop leaders who can lead in solving problems based on the "three realities" technique: on-site, physical, and realistic. Leaders take the lead in cultivating a religious belief in the Lean culture of the company, prove by the results that Lean Manufacturing (LM) becomes the soul of the leaders, and become a Lean Manufacturing (LM) practitioner. For example, 3M is a permanent leader in the innovation industry, and its strong leadership is the hallmark of 3M. Michael Roman, Chairman of the Board and CEO, proposed the goals of driving growth, including four aspects: 1. portfolio, 2. transformation, 3. innovation, and 4. people and culture, which has a significant relationship with the leadership of the leader (Peterson, 2021). Finally, set team goals higher than industry peers by 20 ~ 25%, setting high goals for the organization but not so high that the target is impossible to achieve. This is also a test of managers on their own must set high goals for themselves and, at the same time, highlights the company's growth to stand out from their peers. The target setting must not be changed midway; if KPI fails to meet the target, use root cause countermeasures (RCCM) to analyze the problem and find the root cause to solve it immediately. We do not have Gap, only go to get. For example, the Crisis Management Teams (CMT) of Covid-19 have clear Goal-oriented objectives and set their national objectives for each country. There are significant differences in the prevention and control of the outbreak.

The personal, economic, and public impact on individual countries varies depending on the country's goals (Thielsch, Röseler, Kirsch, Lamers & Hertel, 2021). With key free cash flow growth metrics in place, manufacturers will better understand the importance, urgency, and interplay of various courses of action to address problems at the most fundamental level of day-to-day management. By understanding the benefits of lean manufacturing in growing free cash flow and increasing market competitiveness, they will be more willing to participate in lean manufacturing training and no longer view such training as a waste of time. In addition, company personnel will realize that TPS/Lean Management System is a tool that must be studied and practiced to be used effectively. Another insight is that if all employees can participate in Lean Manufacturing, they can enjoy the benefits of working smart, not working hard, thus improving the whole company's productivity. In addition, the survey we did confirmed that companies that practice Lean Manufacturing have proven that they are indeed successful in growing their free cash flow. In addition, we have started to use AHP and DEMATEL to do factor analysis and impact correlation as a method of company decision-making. Finally, we have shown that using TPS/Lean management systems is necessary for modern business management. Our findings reaffirm the attractiveness of TPS/Lean Management and demonstrate the applicability of the Lean Manufacturing Model to large companies, small businesses, and all management situations involving production.

Most business people do not reap the full benefits of the Lean Manufacturing model because they have not completed the necessary training. The wrong tool without proper training is counterproductive, and the benefits are not realized. Therefore, TPS/Lean management includes many practical tools, and managers must be thoroughly familiar with TPS/Lean work methods and the synergies between these tools. It is important for managers to be thoroughly familiar with TPS/Lean working methods and the synergies between these tools and to practice how to increase free cash flow, reduce waste, and improve the company's overall efficiency. In practice, lean manufacturing increases free cash flow and active capital. Therefore, properly enhancing this advantage can greatly improve a company's ability to expand its business and make acquisitions. This paper shows that implementing lean manufacturing has a complementary effect on strategic deployment (PD) and strategic planning (KPI) in terms of long-term and short-term indicators of free cash flow growth, enabling managers to have a good grasp of the company's operating conditions. With short and long-term goals to measure and leaders who understand the Lean Manufacturing model in depth to lead the team, company-wide efficiency is improved, resulting in growing free cash flow. Lean manufacturing has been proven to be a good system, but it cannot be automated and must be driven by good drivers and leaders. People are the key to success, and with full participation in Lean Manufacturing, growing free cash flow is a sure thing; it is a simple cause-and-effect relationship.

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