Quantifying a Fair Labor Value For Garment Production through Prediction of Factory Efficiency

by

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B.E. Engineering Science, Stony Brook University, 2014

Submitted to the MIT Sloan School of Management and the Department of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degrees of

Master of Business Administration
and
Master of Science in Civil and Environmental Engineering

In conjunction with the Leaders for Global Operations Program at the Massachusetts Institute of Technology

June 2019

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Abstract

Li&Fung is a world leader in logistics, sourcing, and procurement; connecting manufacturing vendors with major retail brands. Recently, there has been an increasing consumer demand for more sustainably produced and sourced garments. When sourcing a garment, costs such as materials, shipping, and taxes are widely understood, but there is a lot of ambiguity on labor's contribution to the cost breakdown. This ambiguity can lead to incorrect garment pricing which can result in factories using cost cutting measures in order to meet production agreements. This in turn can lead to poor production quality as well as adverse conditions to the health and wellbeing of workers.

Through advancements in technology and data collection it has become possible to digitize a large portion of the sourcing process, allowing for a quantifiable approach to costing out labor. The primary goal of this thesis is to detail a methodology to quantify a fair labor value for new orders placed with Li&Fung. A fair labor wage, in accordance with the UN International Labor Organization (ILO), will satisfy the basic needs of workers and their families while providing some discretionary income.

The resulting framework was used to create a model that leverages Li&Fung's internal supplier data currently being collected, as well as external environmental data that drives garment production efficiency. The model provides a standardized, intuitive method for both Li&Fung merchandisers and their customers to determine what a fair labor value is when producing a garment. Additionally, Li&Fung can leverage the tool as a method to attract new brands who are interested in offering fair trade products to their customers, but do not have the capacity or supply chain expertise to do so.

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Acknowledgements

I would like to thank Li&Fung for welcoming me into their organization and giving me the ability to have this once in a lifetime experience to not only work in Asia, but allow me to work on such a meaningful project that has the potential to positively affect the lives of so many workers. Touring factories and seeing first-hand what goes into making a shirt has given me a completely new perspective on the decisions we as consumers make, and how it effects much more than just what we see. With this, I would also like to sincerely thank Pamela Mar as well as Paul Fowler for demonstrating what it means to be a socially responsible leader. You are both true role models for how senior leaders should work to make the world more sustainable. Additionally, I would like to thank Garry Gordon and Mike Robertson for providing a wealth of knowledge on the apparel manufacturing industry.

I would also like to thank all of my colleagues within Li&Fung who helped make this internship both successful and enjoyable. Everyone within the organization was so kind and welcoming, and I truly enjoyed spending time with everyone, whether in the 10th floor or the Explorium. JP, thank you for your unshakeable enthusiasm. Maybe it is all the hot sauce, but no matter what the situation you have a true ability to see the positive. Vasu, thank you for always being the voice of reason and providing tremendous guidance both personally and professionally. Angel, thank you for always being a great sounding board and doing everything in your power to help someone from the MIT family.

I would also like to extend a special thank you to everyone in the MIT community who made this project a success, especially my supervisors. Charlie, Vivek, and John, thank you for all of your support. Your recommendations and guidance both from a technical perspective as well as an organization perspective helped me tremendously in achieving my goals. Additionally, I would like to thank everyone in the LGO class of 2019 for always making me feel like I wasn't very far away, even if I was across the world.

Finally, I would like to thank my family. Being so far away from home definitely had its challenges, but my family has always provided unconditional love and support. Mom, Dad, Roro, Zena - thank you for always being there for me.

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Chapter 1: Introduction

1.1 Project Motivation

In the world of retail manufacturing, the apparel industry has been plagued with issues related to labor. Continuously changing customer desires and a demand for cheaper goods has brands relentlessly pursuing lower costs and faster turnaround times. As brands work to create a competitive advantage through reduced lead times and greater inventory turnover, there is a heavy burden placed on factories to fulfill orders, the brunt of which falls squarely on the shoulders of the laborers.

Li&Fung (LF) has proven to be a consistent driver of practices that empower garment workers within their network of factories. This is evident through key strategic initiatives such as working with factories within their network to pay their employees using digital payments, creating industry standards for labor practices, and paving the path for increased supply chain transparency. This commitment to improving how factories work, and ultimately the workers that comprise those factories is demonstrated in LF's three-year plan:

Externally we're working with key vendors to help redesign their processes and improve productivity, visibility, and accuracy on the production floor. A critical issue facing many factories today is that they can only measure output. Vendor Support Services (VSS), our team charged with finding solutions to challenges at the manufacturing end of the supply chain, is working with factories to help suppliers move to a performance-driven model. [1]

This move to a performance driven model is an undertaking that will require lean process redesigns as well as a major effort to digitize the customer experience and day to day operations, both at the factory level and within LF. The digitization effort is an integral part of LF's supply chain of the future. However, the drive to digitization goes beyond bringing transparency to the supply chain.

Apparel manufacturing is oftentimes a gateway for economic development as it does not require highly educated human capital or sophisticated production equipment, but rather a low cost workforce [2]. However, as an economy develops, it is imperative that workers have a safe working environment and are compensated appropriately for their labor. By being paid a fair labor wage, they can then invest in the development of their communities through both human and economic means.

1.2 Problem Statement and Hypothesis

A major challenge within the apparel industry is a lack of oversight within factories. These factories are often located within emerging economies that do not always have governing bodies ensuring their health and safety. Compounding the issue, the minimum wages set by these countries are not necessarily indicative of the monetary compensation needed to sustain an individual on a day to day basis, let alone a family or creating any type of savings.

To add to the problem, there is an additional layer of complexity related to sourcing and costing a garment. When breaking down the cost of a garment, costs such as materials, shipping, and taxes are widely understood, but there is a lot of ambiguity on labor's contribution to the cost breakdown. This lack of transparency results in labor costs being squeezed when negotiating manufacturing costs, fostering compliance problems and the potential to adversely affect a brand's reputation.

Li&Fung is currently building an end-to-end digital platform, connecting vendors and buyers in a way never before done on such a large scale. An integral component within the LF platform is a digital costing tool. With digitization, it becomes possible to quantify a "fair labor" value and set a threshold for both buyers and factories to adhere to. This threshold has the potential to eliminate costs related to labor compliance, and create an additional revenue for brands who can now position their garments as fair-trade goods.

For this project, it was imperative to establish a standardized methodology to predict what a "fair labor" value should be on a per garment basis. The model needed to be robust enough as to capture all the pertinent elements as it relates predicting a factory efficiency yet intuitive enough to be understood by factory owners as well as LF merchandisers as to augment the goal of transparency. Through this model, it becomes possible to identify methods to reduce costs as it relates to garment manufacturing through changing of features and operations, as well as inform factories of their efficiencies related to manufacturing and resources, and identify improvement opportunities that would result in the greatest impact to improved efficiency.

The methodology and approach used in calculating a fair labor wage was that established by that of the Fair Wear Foundation (FWF), which uses standard minute values (SMV) necessary to produce the garment, the labor minute cost, and the efficiency of a factory. The Fair Wear Foundation derives their labor standards from the International Labor Organization and the United Nations Norms. Historically, Li&Fung employees rely on a priori knowledge to evaluate labor rates. Within this calculation, factory efficiency requires several inputs to be derived, ultimately relying on both external third-party data, as well as data collected directly from partner factories. Under this approach, two primary research areas were explored. (1) Given the limited amount of internal costing data, as well as disaggregated structure of data collection, would it be possible to establish a standardized costing method solely through internal digital costing sheets? (2) By supplementing internally collected factory data with third-party metrics, would it be possible to assess and differentiate factories manufacturing efficiencies?

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Chapter 2: Company and Project Background

2.1 Company Background

2.1.1 History of Li&Fung and the Fung Group

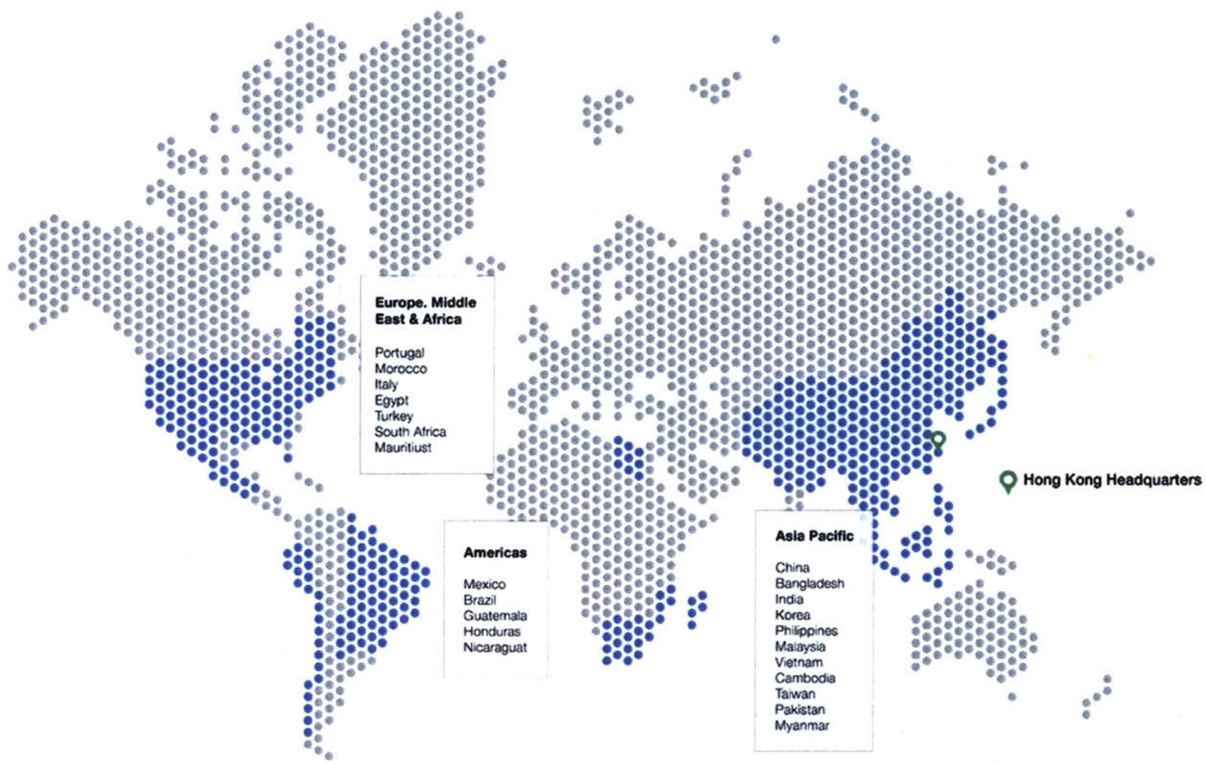
In order to understand Li&Fung's drive towards digitization and the supply chain of the future, it is important to first understand the history of the company. Li&Fung was founded in 1906 in Guangzhou, China by Li To-ming and Fung Pak-liu. Both entrepreneurs, their Canton-based trading startup became one of the leading export firms in Canton before relocating to Hong Kong following the Sino Japanese War in China. Li&Fung quickly became one of Hong Kong's largest exporters of garments, toys, and electronics, with a mission to bring eastern goods to western consumers. [3]

Although their startup initially began with the exports of Chinese porcelain, silk, handicrafts, and fireworks, Li&Fung has evolved tremendously over their historic 110+ year history, growing to become a pioneering multinational global supply chain manager with a presence across the globe, including the Americas, Europe, Africa, and Asia [4]. Today, the Fung Group, the parent organization of Li&Fung, is leveraging their asset-light business model to transition to a digitally focused company. By relying on their people, relationships, and rich historic knowledge, they will be able to help their customers navigate the digital economy and drive growth and innovation through creation of the supply chain of the future.

2.1.2 Corporate Structure

Today, the Fung Group is operated by the fourth generation of the Fung family and is part of a larger ecosystem working to transform the future of retail, logistics and supply chain., driving Li&Fung towards a more agile business model . The Fung Group comprises more than 42,000 people across 40+ markets worldwide in over 350 offices. Together, the Fung Group generates over $22 Billion in annual revenue [5]. The following visualization shows the extent of the Fung Group's global supply chain.

Figure 1: Fung Group Supply Chain



The Fung Group is broken down into four main companies: (1) Li&Fung, (2) LH Pegasus, (3) Global Brands Group, and (4) Fung Retailing Group. These companies span the entire consumer goods global supply chain, including sourcing, logistics, distribution and retail. Li&Fung is the world's leading consumer goods design, development, sourcing and logistics provider for global brands and retailers, and is comprised of two main services, (1) supply chain solutions and (2) logistics solutions. Li&Fung's planned digitization of their supply chain is meant to not only improve current solutions being offered to customers, but also to find new offerings that will drive growth across the entire supply chain. The scope of this end-to-end supply chain is pictured in the following figure.

Figure 2: Scope of Li&Fung's Business

2.1.3 The Fung Academy

The Fung Academy is an initiative set forth by the Fung Family in an effort to accelerate learning within the Fung Group, allowing for constant growth and development. The Fung Academy provides four distinct functions: (1) the program for management development, (2) corporate capability development, (3) innovation and experimentation, and (4) supply chain futures. Within the Fung Academy, the LGO program is primarily aligned with the supply chain futures division. Supply Chain Futures, led by Ms. Pamela Mar, focuses on projects aimed at helping both the Fung Group as well as their suppliers build capabilities and improve operations through improved data utilization and digitization. Additionally, there is a strong emphasis on the exploration and implementation of new or underutilized technologies such as blockchain and RFID, in order to understand potential efficiency improvements, while driving towards the overarching mission of the Fung Group to build a sustainable, transparent supply chain that creates a competitive advantage for both the Fung Group and their partners, helping to pioneer the consumer goods supply chain.

2.2 Project Background

2.2.1 Challenges Surrounding Labor for Garment Manufacturing

The Apparel industry is valued at over $1.5 trillion, with the vast majority of major brands being headquartered in high-income countries. Due to the need to keep costs down while quickly adapting to rapid, market driven changes, production of garments are typically outsourced, primarily to the Asia region where brands can capitalize on relaxed government regulation and low cost labor . As the provisions regarding manufacturing oversight are scarce in these developing countries, there is a tremendous amount of difficulty in relation to ensuring workers within factories are treated fairly and are compensated adequately. There is a multitude of issues surrounding workers in these developing countries including but not limited to the following:

- gender based violence- due to the predominantly patriarchal management structure within factories, coupled with high concentration of women workers in the garment manufacturing space, the majority of whom are in low-skill departments and tasks, there is a high susceptibility to gendered aspects of violence, defined as violence against a woman because she is a woman, as well as violence directed against a woman that disproportionally effects women due to (1) high concentration of women and (2) gendered barriers to seeking relief [6].
- unsafe working conditions- often times referred to as “sweat shops”, these manufacturing operations take place in factories that have unreasonably authoritarian management, and impose dangerous and unhealthy, both physically and mentally, risk to workers, through poor physical infrastructure, overcrowded spaces, and limited employee rights.
- illegal subcontracting- factories may outsource work to other factories in order to reduce costs or complete an order without the knowledge of the agency who placed the order. These subcontractors are “off the books”, meaning there is no way for a higher agency to track the work they are doing or even their location, leading to virtually no oversight on the factories performing the subcontracted work, leading to unsafe labor practices, quality concerns, as well as other dangers that arise from these cost cutting measures.

- unfair wage practices- many labor problems transcend past the workplace, affecting workers and their families due to pay. Unfair labor wages is a major problem within apparel manufacturing and include (1) unfair labor wages, (2) unfair pay structure, and (3) withholding of pay. Unfair labor wages is defined as wages that do not meet the minimum amount needed to sustain basic necessities of the worker or their family. Unfair pay structure can contribute to workers not receiving enough compensation for their work or the withhold of pay altogether. This commonly occurs when workers are paid on a piecewise basis, meaning they are compensated for each item the produce. If their equipment breaks down, or if there is any defect in the garment, even if it is not the fault of the laborer, they may not receive compensation. Additionally, workers are often time payed as contractors, meaning workers are treated as temporary employees, where factory owners are able to avoid paying certain non-wage benefits, such as healthcare or bonuses, and can drop the contract worker at any point. This is due to the extreme seasonal variability of production. These short term contracts coupled with unrealistic production targets can often lead to excessive working hours, driving wage related rights abuses and unsafe working conditions.

There are a multitude of endogenous factors that contribute to the aforementioned issues. When examining the management structure, it is apparent that there is a very hierarchical work relationship, which leads to authoritarian relationships between management and workforce. Compounding this with strong anti-union management practices and low levels of worker education, it makes it very difficult to break the cycle from the ground up, as the workforce often times has no way to organize, and nowhere else to turn to, either in seeking new employment opportunities or pushing back on their current employers. When discovered, whether it be through employee strikes or disasters such as the Rana Plaza collapse, there can be catastrophic loss of life, and unrecoverable damage to a brand's reputation. With the global uncertainties faced in the market today, workers are the unfortunate bearers of the brunt. Due to erratic buyer purchasing patterns, workers are forced into contracts that give all the power to their employers, leaving them with job uncertainty during periods of fluctuation and downward pressure on wages. Workers face further obstacles in relation to collective bargaining agreements that undermine their power to negotiate fair rights.

2.2.2 Corporate Achievements Related to Labor Rights

Issues pertaining to the fair treatment and compensation of workers in garment factories has been coming to light much more so in recent times. According to research conducted by SalterBaxter, a leading management consultancy firm specializing in helping retail brands become more sustainable, there has been a growing number of consumers interested in the provenance and journey of their garments. Consumers are becoming more conscious to how their buying decisions effect those that they cannot see or interact with, and want to be reassured that their purchase didn't have a negative social or environmental impact. In response to this demand, major brands have undertaken initiatives increasingly focused on delivering goods that can be deemed "fair trade", allowing factory workers to receive enough compensation to meet their average living costs while also allowing for the saving of additional discretionary income. Additionally, many new brands have emerged, claiming "radical transparency", promoting an ethical manufacturing of their goods. Such instances of this occurrence is highlighted below:

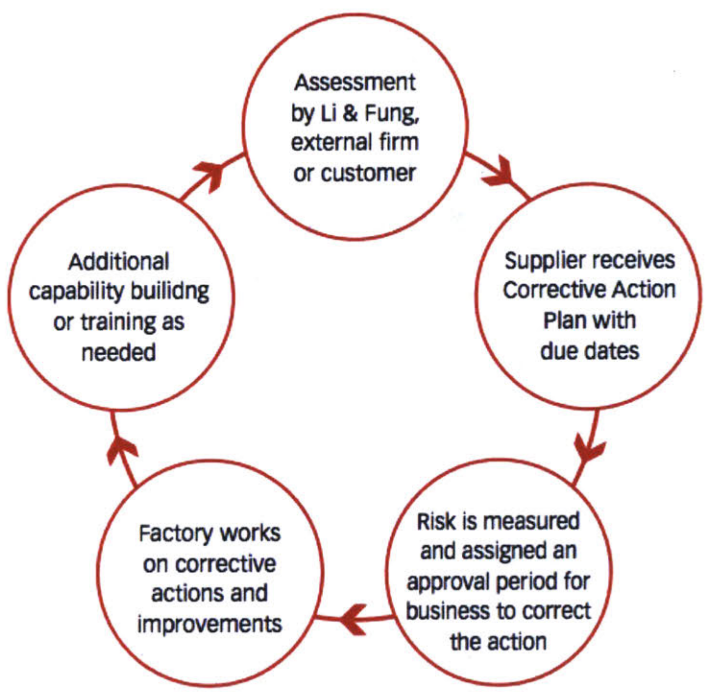
- H&M implemented a new wage management system that promotes better work environments and fairer wages within 500 supplier factories. Their primary goal is to create a positive and more productive work environment through an improved wage management system and fostering more dialogs between employers and employees. [8]
- Levi's launched a worker well-being initiative currently being used to make 70% of Levi's product line, aimed at providing "financial empowerment, health and family well-being, equality and acceptance." This initiative currently impacts over 100,000 employees across 12 countries with commitments to increase to 80% of the product line by 2020 [9]
- Everlane, a relatively new retailer that has seen explosive growth, is built on the premise of an ultra-transparent supply chain, working closely with factories to ensure workers are compensated fairly, and all additional labor concerns such as hours worked, factory conditions, and workers rights are all mitigated correctly.

This brief list of examples demonstrates some of the positive impacts that have occurred, helping bring better conditions to workers within factories. Li&Fung has been a pioneer in this field, creating several initiatives to increase transparency and worker's rights within their supply chain, such as the implementation of RFID, as well as new initiates such as the workers app, a tool designed to be used by all factory employees to educate them on critical life skills as well as allow them to engage with management and allow them to voice their concerns [10]. Additional initiatives, such as the fair labor costing tool explained in greater detail in this thesis, demonstrate the commitment to improving factory worker rights. As in an industry leader, it is important for Li&Fung to set this precedence.

2.2.3 Risk Mitigation within Li&Fung's Supply Chain

Li&Fung is currently in the middle of their three-year plan, with a major effort to reimagine today's supply chain to create a digital end-to-end network. As denoted in previous sections, mitigating risk is an extremely important value that Li&Fung provides, and the push for digital will not only help to strengthen the ability to manage risk, but also allow for quicker mitigation of problems that arise through a more robust, agile supply chain. The following figure demonstrates the risk mitigation cycle that Li&Fung currently uses.

Figure 3: Li&Fung's Risk Management Cycle



There are many factors outside of the scope of this paper which Li&Fung are currently implementing to mitigate risk within their supply chain, including additional trainings of quality assurance/quality control teams, who are in factories regularly. However, there are additional measures that Li&Fung is using, including endogenous factors that determine factory risks, such as monitoring of orders through RFID, end of line QC apps, digital payments of laborers as well as the worker app which allows workers to provide feedback to management and promotes worker health and wellness. Li&Fung also continuously engages with policy makers to ensure that they are adhering to best practices, ensuring that both they and their customers are ahead of the curve in all matters related to risk management.

2.2.4 Current Garment Costing Practices

When producing a garment, merchandisers are the people working with retailers and brands to create the finished goods. Merchandisers are involved with all aspects of the supply chain, coordinating vendors, suppliers, and logistics to ensure proper production and on-time delivery. There are four stages that comprise the lifecycle of a product which include (1) design and product development, (2) sampling, (3) costing, and (4) production and delivery. In order to understand the necessity of the fair labor costing model, it is important to understand situationally how this tool will be engaged as well as the current process to develop and cost a garment. Within the design and product development stage, a strong emphasis is placed on understanding customer requirements, which involves researching customers as well as understanding brand positioning. As mentioned in previous sections, customer trends have begun to shift towards transparency and a desired ethical treatment of laborers, which is why a fair labor costing tool is instrumental as a value proposition for brands, and consequentially for merchandisers to leverage.

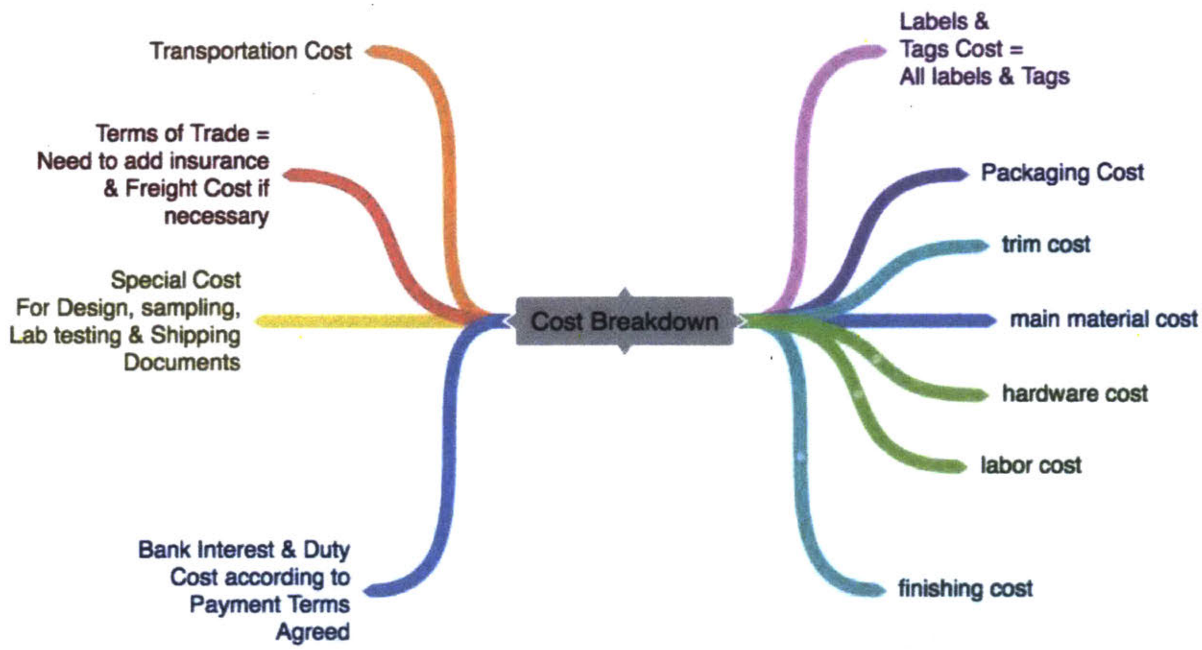
After the merchandisers have confirmed the product requirements and have had the product samples approved, the next step is costing the item. The current process to cost a garment is done in a 6 step process:

1. Advise costing requirements to factories- this traditionally involves inspecting factories for quality standards including workmanship and testing
2. Get price quotations from vendors- this step involves getting several price quotes from various vendors, then comparing them for accuracy and competitiveness. Quotes are traditionally collected using a customer provided template that has a cost breakdown based on information the customer wants
3. Review price quotations with customer and get customer's comments
4. Negotiate price with vendors to meet customer's demand
5. Confirm price options with customer
6. Order confirmation and issue contract

Within this process, customers and merchandiser's rely on a priori knowledge from previous styles that are similar to determine an estimated cost, then compare and negotiate with multiple vendors to find the most competitive price. This method does not leverage the data currently being collected, which is why Li&Fung is working on building a digital costing tool, that will allow vendors, merchandisers, and customers to offer quotes digitally, as well as estimate costs of garments based on the actual prices of the various cost components.

It is important to note however, that due to the proliferation of costing sheet styles, it is very difficult to standardize costing breakdowns, as customers will have different requirements for what constitutes different cost components; i.e. if one customer considers materials to be fabric, trim and hardware (buttons, zippers, etc.) while another customer only considers materials to be fabric and categorizes hardware separately. A common comprehensive cost breakdown of a garment is shown in the following figure.

Figure 4: Comprehensive Cost Breakdown of Garment



Understanding labor costing methods will be explained in greater detail in the coming sections. It is important to note, however, that within the above mentioned cost breakdown, all figures are commonly considered "hard costs" i.e. easy to find or calculate, with the exception of labor. This component can often times be very ambiguous and can vary greatly based on several factors including location of factory, order size, garment type, factory sophistication level, efficiency etc. This ambiguity makes it difficult to hold both factories and buyers accountable when settling on an FOB price.

Chapter 3: Literature Review

3.1 Understanding Labor Trends

Global trade plays a dominant role in today's world, relying on buyers sourcing from a network of suppliers competing for business. This method of conducting business puts the responsibility of wage compensation at the hands of the suppliers, who are under significant pressure to meet margins, oftentimes effecting the wages and conditions they offer their workers.

It is widely recognized by industry practitioners that labor practices within the garment sector face serious concerns. Issues surrounding adequate compensation, health and safety in the workplace, and unsustainable working hours cause tremendous burdens on laborers, and can potentially lead to major disasters. In an effort to combat these practices, organizations such as the International Labor Organization (ILO) work to counter the ever present "race to the bottom" between brands and factories. As Defined by the ILO, labor protection is about "shielding workers from exploitation, from risks of ill health or danger, from unduly low or irregular earnings, from unpredictable work schedules and from excessively long hours of work. It enhances the ability of workers and their families to pursue their material well-being in conditions of freedom and dignity, economic security and equal opportunity, and to adapt to changing work and life circumstances [11]." The path to protecting laborers has had milestone accomplishments, as well as tragic events. Although certain measures such as minimum wages and standard working times may appear to be costly to implement in the short term, the long term effects may create a substantial benefit to the factory through increased productivity and lower employee turnover.

As the global economy has taken form throughout the past several decades, there have been significant changes to the way in which work is conducted. Early on, post-world war II, a strong economic growth fueled increased job opportunities and standards of living. During this time, worker productivity increased, there was strong job security, and labor unions dictated the labor market and protection rights. As time has elapsed, unions have dwindled, and the lack of collective bargaining as hurt workers, ultimately aiding the factory owners who disregard the rights of laborers, as there is no repercussions for not bargaining. This decline in collective bargaining power has been a point of significant contention, as the debates around the trade-off between job creation and employment in impoverish areas versus fair labor rights and protection lead many to figure out how to balance the two sides. As it pertains to this debate, however, it has been shown that labor protection has no, if very little, effect on employment, and thus should not be used as a leverage point to justify not adhering to fair labor standards [12].

3.2 Effects of Technology on Labor

The rise of technology has proven to be a double edged sword as it relates to its effect on labor. although there have been marked increases in productivity, the acceleration of product development and narrowing of temporal distances has demanded a non-standard employment relationship marked with an increase in hours needed to work and faster turnaround times. As much of the world's developing countries operate in the informal economy, the unpredictability of work as well as wages creates tremendous amounts of problems with implementing labor rights. Despite a tremendous amount of effort to reduce the number of people working below the extreme poverty line of US $1.25 a day, there are still over 300 million working men and women, and their families still living below that threshold. Even though technology has created increases in productivity, there has been a marked divergence in labor productivity growth and wage growth.

Figure 5: Divergence Between Labor Productivity and Wages

Figure 5 shows the divergence between the average wages as well as average labor productivity between 1999 and 2013. As demonstrated above, the growth of wages compared to the growth of productivity has been unequal, particularly from 2010 and beyond, as average wages as remained relatively stagnant while labor productivity has grown tremendously [13]. The attributing factors that contribute to these trends include the reduction of bargaining power of laborers, increased pressure to maximize shareholder value, as well as the increase in global trade. Unsurprisingly, these factors create this unequal divergence.

3.3 Institutional Support for Labor Rights and Defining Fair Labor

There are several institutions and governing bodies supporting labor rights initiatives. The most prominent is the United Nation's International Labor Organization (ILO). The ILO is a tripartite agency which creates policies and programs aimed at creating better working condition with the inclusion of governments, employers, and workers. They are working to create an international labor standard and work with several organizations to ensure that the standards set are met.

Some of the additional organizations that partner with the ILO include BetterWork, an active buying partner of Li&Fung, has helped improve the lives of over 2 million workers through on the ground changes that include education services, advocacy of new policies, and continuous assessments [14].

The Fair Wear Foundation (FWF) is a world renown non-profit organization that works with all stakeholders within the supply chain including brands, factories, workers, and governments to improve and keep track of workplace condition improvements. FWF has derived a comprehensive list of labor standards using a multi-stakeholder structure, including ILO conventions and the UN's declaration on human rights, ensuring industry wide cooperation and ultimately industry wide improvements. The list distills down to the following 8 principles [15]:

- Employment is freely chosen, meaning no forced labor including bonded or prison (ILO conventions 29 and 105)

- No discrimination in employment in regards to recruitment, wage, training, promotions, non-wage benefits etc., based on the principles of equal opportunities including race, religion, gender, color, etc. (ILO conventions 100 and 111)
- No use of child labor, defined as anyone less than the age of completion of compulsory schooling, understood as anyone under the age of 15 (ILO convention 138)
- Freedom of association and the right to collective bargaining- workers are allowed to organize and join trade unions and bargain collectively (ILO conventions 135 and 143)
- Payment of a living wage- wages and benefits paid to workers that meet at least legal or industry minimum and is enough to provide the basic needs of workers and their families while providing some discretionary income (ILO conventions 26 and 131). The living wage definition will be defined further in the thesis, however it is important to mention that deduction from wages as a disciplinary method is not permissible, and employees should be informed adequately and clearly about the specifications of their compensation including rates and pay period.
- Reasonable hours of work defined as not having to regularly work in excess of 48 hours per week, have at least 1 day off per 7 days, and will be compensated at a premium rate for overtime, which must also be voluntarily worked (ILO conventions 1).
- Workers must have safe and healthy working conditions, including measures meant to prevent and minimize health risks. Physical and mental abuse is additionally strictly prohibited (ILO conventions 155)
- Employment relationships should be legally binding as to avoid labor-only contracting relationships as well as apprenticeship schemes with no plans to hire or compensate an employee

Although this the organizations highlighted above is not exhaustive, it demonstrates a commitment to improving worker rights through policy changes, program initiatives, and increased monetary compensation.

3.4 Market Trends and Production Processes

There has been substantial changes in the market recently, fueled by shifting customer demand as well as advances in automation. With a US-China trade war looming, there has been an even greater demand for agile and resilient supply chains, with an increased ability to manufacture faster and with more flexibility.

Examining customer trends, there has been an increase in demand for faster, more customized clothing, while still demanding lower prices. Of the $1.2 trillion global fashion market, the United states accounts for an annual spend of $250 billion, a number that continues to increase. The American consumers are unaware that their desire for cheaper goods fuels deeply controversial practices within the apparel industry.

However, there have indeed been changes in the way consumers purchase, with a greater demand for retailers to disclose where their goods are produced. This is seen through campaigns such as #GoTransparent, requesting major brands share what factories they are using, which garnered over 70,000 signatures. Additional pressure from consumers has driven governments to also get involved, including pledges from the U.K of $53 million to help with human rights within the garment industry.

In order to meet the demands of customers and industry, there has been a rise in automation. Automation allows for lower costs to produce garments, while giving more flexibility to the manufacturing process. There are several challenges associated with automation however, including job displacement, but there is also a creation of higher skilled jobs for the repair and operation of this equipment.

3.5 General Sewing Data

General Sewing Data (GSD) is a predetermined motion time system first published in 1978 created specifically for the garment manufacturing industry. The GSD tool uses a breakdown of the movements an operator makes to produce the garment and assigns each movement with a "standard time" necessary to complete the task. This methods analysis is used in factories and traditionally requires a team of industrial engineers to evaluate the operator motions to derive the breakdown and, using the synthetic data within GSD, calculate the time measuring unit values [16].

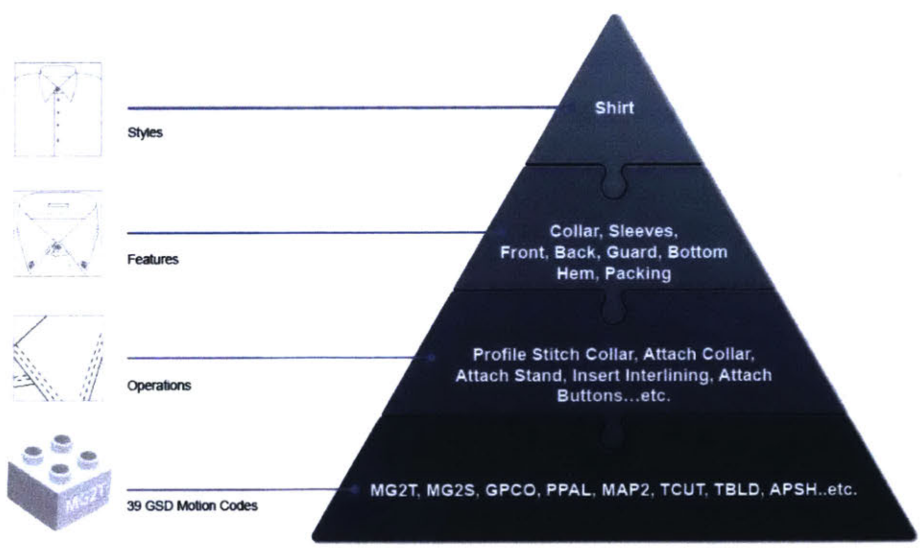
GSD uses 39 predetermined motion codes which are used to derives standard minute values by examining the motions an operator needs to both handle and machine parts. These motion codes are used as the foundation to create any type of operation, which is then used to build the features of that garment, which comprise the total finished good. An example of using pre-determined time motions to understand the operations that comprise a shirt to establish the SMV is shown in figure 6 [17].

The GSD motion codes examine all steps an operator needs to complete a part, which includes what is being done with each hand, turning motions, etc.

Table 1: Example of GSD Left and Right Hand Operations

Left Hand	Right Hand
Holding Part	Get Scissors
	To Thread
	Re-grasp Scissors
	Cut Thread
	Aside Scissors

Figure 6: Example - GSD Predetermined Motion Codes to Establish SMV of a Shirt



With this method, it becomes possible to standardize time calculations in a scientific and objective manor. Using the GSD enterprise tool requires specialized training in order to become a licensed GSD practitioner. These people are often industrial engineers working either at the factory level or working exclusively with vertically integrated brands in order to understand actual factory capacity, line balancing, and realistic performance targets. This method, although very effective, is difficult to implement within Li&Fung due to the large volume of orders placed with the business.

Instead, an alternative to the enterprise tool is GSD Quest, a software application developed for non-technical staff, which uses standard product templates, such as shirts and jeans, and allows for features to be added via drag and drop within the software. This method, which can be used relatively easily by merchandising teams, would allow Li&Fung to easily perform a much more accurate time analysis. For this reason, the model leverages this intuitive approach to derive SMVs.

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Chapter 4: Methodology

4.1 Methodology Introduction

The methodology used to create the fair labor costing tool uses the approach taken by the Fair Wear Foundation (FWF) to establish living wages [18], in combination with the approach taken by the General Sewing Data (GSD) quest tool to establish standard minute values to produce a garment. The methodology established by the FWF is designed to incorporate the eight labor standards derived from ILO conventions and the United Nation's Declaration on Human Rights (outlined in section 3.3 *Institutional support for labor rights and defining fair labor).* In conjunction with GSD data used to establish standard minute values as well as Li&Fung's internal data to predict factory efficiencies, this methodology establishes an effective, comprehensive approach to determine how much brands should be paying on a per garment and per style level for labor cost, to ensure factory workers can make a fair, livable wage that can be easily understood by both merchandisers and brands.

4.2 Labor Minute Costing

4.2.1 Implementation Assumptions

The strategy employed by the Fair Wear Foundation is designed to address and overcome obstacles related to the payment of living wages, specifically as it relates to calculating realistic estimates for how much it will cost a factory to increase the wage of its lowest paid worker on a per-garment and per- style basis. This method addresses a very important concern related to ensuring increased wages are built into normal product costing systems in a transparent, verifiable, and replicable manor. It is also important to note that this method is meant to share the increased costs across all factory customers as not to violate government set competition laws.

There are several assumptions that the FWF methodology is based upon in regards to the nature of the relationship between the sourcing agent and the factories. The sourcing agent, whether it be internal to a brand or a provider such as Li&Fung, are critical to the successful implementation of a fair labor pay structure, and because of this, the success of the fair labor costing tool relies on similar assumptions.

The following assumptions must be realized in order to insure the successful implementation of a fair labor payout strategy:

- There must be a high level of trust between the sourcing agent (whether it be Li&Fung or a vertically integrated brand). This typically occurs when there is a long standing relationship between the factory and the sourcing agent. This is a very important point as it helps to establish which factories Li&Fung should target for a possible pilot project.
- The Factory must have a firm understanding of their costs, as it relates to all of their ancillary overhead, as well as all costs associated with manufacturing of product. This is essential to determining prices as well as providing transparency with the sourcing agent. Alongside this, there must a willingness between the factories and sourcing agent to disclose costs (this relationship has already been implemented by a number of brands and factories). With this agreement, sourcing agents and factories agree to all chargeable costs as well as the margin made by the supplier. At a minimum, factories need disclose the total cost of working minutes in order to have a meaningful and quantified negotiation around fair labor rates
- Factories and brands must be willing to use third party verifications to ensure additional wages being paid for fair labor are being paid out correctly. This step is crucial to ensure laborers are actually being compensated. In this step, Li&Fung can play the role of verifier, not only through physically performing audits, but additionally through the use of digital applications such as digital payments to the entire work force, so it becomes much easier to track payments, something that Li&Fung is currently working on implementing throughout their entire factory base.
- Factories and brands must be willing to negotiate with laborers as well as unions in order to establish a fair wage. These negotiations help to ensure the needs of all representatives are met, and that through these relationships, long term standards can be put into place. With this, all brands sourcing from a single factory should be paying an equal amount as to ensure fair competition and anti-trust considerations.

These assumptions are critical to the success of implementing a fair labor tool, as the core principles that comprise these rules ensure not only a way to establish fair labor rates, but also a way to ensure the long term success of fair wage payments. A lot of these rules traditionally apply to brands that are vertically integrated, but can be adopted and successfully implemented by Li&Fung due to their wide spread reach and third party verifier status.

4.2.2 Cost Calculation Methodology

As discussed in section 2.2.4 (*Current garment costing practices*), traditional methods of calculating cost rely on a negotiation from a wholistic point of view, with the total cost of garment production considered in the negotiation process. With the cost calculation methodology used by FWF, as well as the fair labor costing model, labor costs are broken down into their component parts and quantified using a replicable and transparent manor. The FWF costing methodology is used to calculate an overall FOB price. The first step to achieving this method of labor calculation is to understand the working minute cost. The working minute cost is a function of the annual operating costs and the total production time available per year:

$$Working\ Minute\ Cost = \frac{annual\ operating\ costs}{total\ production\ time\ available\ per\ year}$$

As an example, using local factory data for a factory in Bangladesh, assuming 500 operators with 300 working days per year working 8 hours a day, the total production time available would be 72,000,000 minutes. Examining local factory data, typical annual operating costs would be approximately $1,680,000, meaning that the working minute cost would be 2.3 cents per minute.

To understand the impact of changes to wage, the working minute cost must be broken down further into its component costs. Because annual operating costs account for more than just the production time available, the additional factory costs need to be understood and included in calculating working minute cost. Working minute cost can be broken down into three main categories:

1. direct labor- this includes all costs associated with the production of garments such as the operators who perform cutting, sewing, packaging, washing, etc.
2. indirect labor- this includes all costs associated with non-directly related production such as quality control, management, maintenance, planning teams, etc.
3. overhead- this includes all ancillary overhead costs such as rent, insurance, utilities, etc.

To understand what percentage each of these components contribute to the total working minute cost, there must be a certain level of transparency between Li&Fung and the factories being used for garment production as outlined in the previous section. For the purposes of the fair labor cost model, regional factory averages were used to calculate the percentages.

Once the direct labor working minute cost is understood, the next step is to understand how much time is necessary to produce a particular garment. The process of calculating the amount of time it takes to make a garment must be standardized in order to ensure consistency and accuracy when pricing the per unit labor cost. On a per garment basis, the amount of time needed to produce a garment is referred to as the standard allowable minutes (SAMs) or standard minute value (SMV). The SMV for most basic garments is commonly understood in the industry, however, due to the varying degrees of complexity between garment styles, each garment has a different SMV. Although there are standard methods to calculating SMVs, the time to produce a garment does become a negotiation point between factories and sourcing agents, which can create a lot of pressure on laborers if the expectations for the time to produce a garment are unrealistic. Additionally, the methods used to calculate SMV of a garment assume 100% efficiency, which is unrealistic in a factory, To mitigate this, it becomes important to use a standard method to calculate SMV, and then include an overall efficiency component to get to the true unit labor cost. Using this method, unit labor cost can be calculated as:

$$Unit\ Labor\ Cost = \frac{garment\ SAM\ \times\ labor\ cost\ per\ minute}{factory\ efficiency}$$

There are several drivers of factory efficiency which need to be explored in greater detail in order to get an accurate estimate. Skill level of the laborers performing the various operations, factory layout, and absenteeism all effect the real efficiency of any given factory. The novel method used to estimate efficiency for the fair labor cost model will be outlined in greater detail in the later sections. With the FWF method, the efficiency of a factory is a point of negotiation between factories and sourcing agents, as opposed to a standardized, quantifiable metric.

Once the unit labor cost is established, the next step is to calculate the cut make trim (CMT) price. The CMT is comprised of the total working minute costs and factory profit margin:

$$CMT\ Price = Unit\ Labor\ Cost\ \times\ Unit\ Non-Labor\ Costs\ \times\ Factory\ Profit\ Margin$$

Profit margin varies based on production country, type of garment, as well as other factors. Margin typically includes profit being paid to the factory owners as well as improvements needed to improve the factory, such as equipment. Being able to establish a fair factory profit margin requires a high level transparency between the factory and sourcing agent, as detailed in the previous sections. Unit non-labor costs are comprised of the remaining total working minute costs (overhead and indirect labor working minute cost) multiplied by the time it takes to make the garment. Once the CMT price is established, the FOB price is easily reached through the additional input of materials and trims.

4.3 Time Study Analysis

The traditional method used to establish time standards for the processes involved in manufacturing garments within the apparel manufacturing industry is through time study analysis. Time study requires the use of a calibrated stop watch to capture the time necessary for an operator to produce a garment, with times captured for each step within the garment manufacturing process. The practitioner conducting the time study analysis also must be proficient in understanding the level of skill and speed necessary to finish each task at pre-defined output levels [19].

This system has several drawbacks, primarily related to accuracy of capturing the timed work cycle as well as integrity of the results. The system relies on the competency of the practitioner to accurately gauge skills of laborers, which can lead to compromises when trying to determine what a fair amount of time to produce a garment should be. This can happen when a very good laborer can set a time that in reality is unrealistic for the group to maintain, leading to additional time needed to produce the entire order.

Aggregated results can also be untrustworthy and inconsistent, depending on who is running the time series study and which operator is performing the task. Additionally, time series analysis is very expensive and time consuming for individual businesses, as an extensive amount of time and effort is spent on proving and improving the time needed to produce each garment as well as setting the time standards. With time study analysis, there is a lot of room for debate, leading to arguments and negotiations between workers and factory owners. Ultimately, this system is not effective due to high cost, lack of accuracy, and lack of standardization. Because of this, many companies have chosen to move to predetermined motion time systems such as GSD.

4.4 Efficiency Evaluation

4.4.1 Traditional Methods for Calculating Efficiency

Traditional methods for calculating line efficiency are done post-manufacturing, and can often vary tremendously during the manufacturing process, as operator performance and management of the line can play a large roll in overall efficiency. When considering operator efficiency, the on-standard efficiency (work being done on the standard job during shift hours) can be severely impacted by external factors, such as machine breakdown, unavailable materials such as trims, power failures, operator sitting idle while waiting for work, etc. Lean practices contribute greatly to increasing operator utilization and improving piece flow rate through functions such as line balancing as well as better operator training, all which help drive efficiency improvements. Additionally, newer equipment and implementation of automation processes help to drive efficiency improvements. These processes and their contribution to efficiency will be explored in greater detailed in the coming sections.

Understanding individual operator productivity is a crucial step to realizing the efficiency of a production batch. The production batch efficiency can at most be equal to, but most often less than the efficiency of individual operators. This is due to the external impacts that effect overall efficiency, such as absenteeism, a large problem in the countries primarily used to source apparel.

To calculate overall efficiency of a production batch, the following information is needed:

- Number of available operators per line working on a particular production batch
- Number of working hours spent working on production batch (both regular and overtime)
- Total number of pieces produced
- Standard minute value (SMV) of the garment being produced
- Total minutes produced by the line, which is a function of number of production pieces multiplied by SMV to produce each garment
- Total minutes worked by all operators

Once this information is understood, it becomes possible to calculate overall line efficiency. This is done through the following calculation:

$$Line\ Efficiency = \frac{total\ minutes\ produced\ by\ the\ line}{total\ minutes\ attended\ by\ all\ operators}$$

Table 2: Example - Line Efficiency Calculations

No. of Operators (A)	Working hours (B)	line output (production) (C)	Garment SAM (D)	Total Minutes attended (E=A*B*60)	Total Minutes produced (F=C*D)	Line Efficiency (%) (F/E*100)
48	8	160	44.25	23040	7080	30.73
48	11	240	44.25	31680	10620	33.52
34	8	300	25	16320	7500	45.96
35	11	400	25	23100	10000	43.29
35	11	329	25	23100	8225	35.61
34	8	230	25	16320	5750	35.23
34	8	200	35	16320	7000	42.89
35	11	311	35	23100	10885	47.12

As these calculations can only be done after production has been completed, it can only be used as an estimator for future production efficiencies.

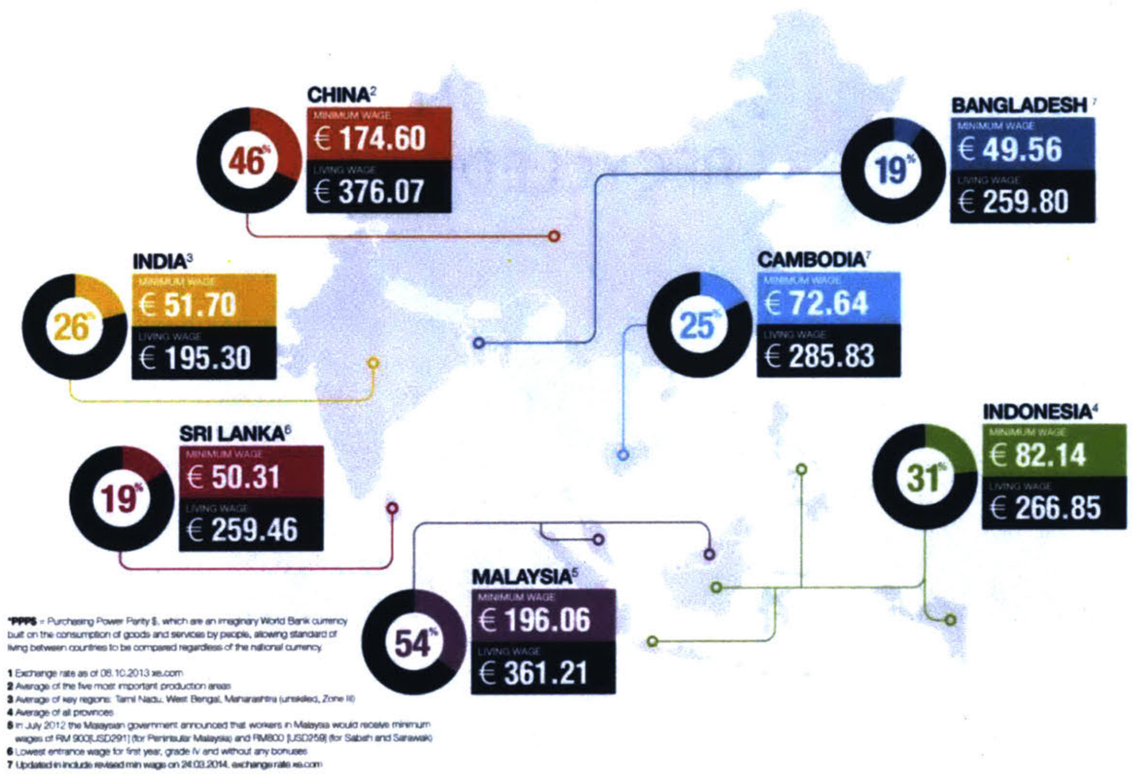
4.5 Labor Wage Determination

There are several organizations dedicated to determining what constitutes a fair labor wage for garment production workers. The rules of fair labor set by the International Labor Organization should be adhered to, and in regards to the breakdown of what laborers should be able to afford, the following metrics are traditionally accepted amongst the organizations working to quantify fair living wages:

- Workers should be able to be able to have enough income to provide an adequate amount of food for themselves and their families. According to the Asia Floor Wage Alliance, the average worker requires 3000 calories a day to sustain themselves during work, and because of this, 50% of a workers monthly salary goes towards food
- Workers should receive enough of an income to cover clothing, housing, travel costs to and from work, healthcare costs, as well as their children's education. According to the Asia Floor wage Alliance, this accounts for approximately 40% of a laborer's salary
- Workers should receive some discretionary income for use for savings such as pension, entertainment, or if the primary household earner loses their job. According to the Asia Floor wage Alliance, this should account for approximately 10% of a laborer's salary

The minimum wages within a lot of these countries is not currently high enough to cover the basic necessities of laborers within the garment industry. Although there have been recent improvements set forth by government regulation in regards to increasing minimum wages, the true difference between minimum wages and fair labor wages and differ on average by over 400% [20].

Figure 7: Annual Minimum Wage Versus Annual Living Wage



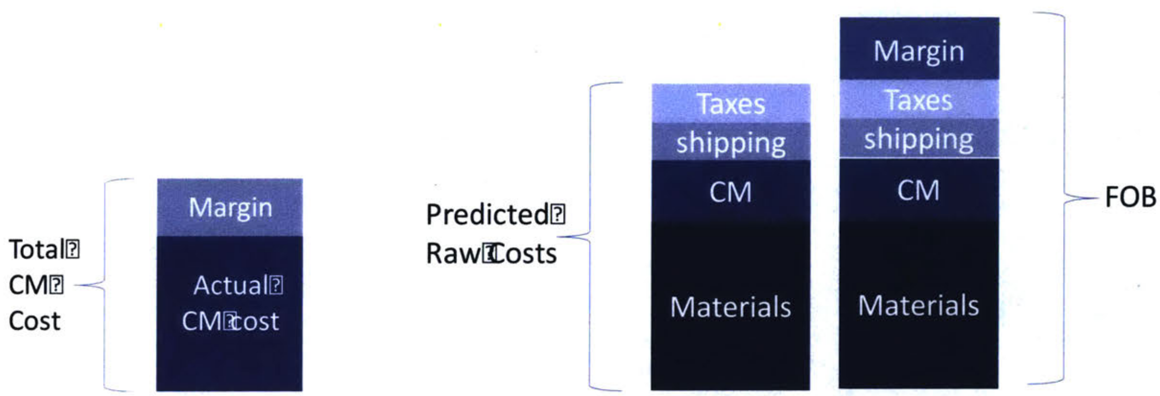
Although these organizations help determine what fair labor rates should be, it ultimately falls on the factories, laborers/trade unions, and governing bodies to establish and negotiate what a fair wage should be. Agreements between all stakeholders ensures that all parties are satisfied, which will help foster the long term success and scalability of fair labor costing implementation.

4.6 Alternative Methods to Derive Per Unit Labor Costs

Due to Li&Fung's extensive work done with costing, an alternative approach was attempted which used historical costing sheets to derive the contribution of labor to the overall garment FOB. This approach uses all components of a costing sheet as predictors of a cut and make value. Although this approach may seem feasible, there were several challenges associated with this method that proved to be intractable.

One of the most difficult aspects of this approach is dissecting the labor cost within the costing sheet itself. Vendors build their margin into the FOB price, so within the FOB breakdown, it is nearly impossible to know what the actual vendor CM cost is using Li&Fung's data. The best option to allow for this is to assume a 5-10% profit margin distributed evenly throughout FOB price breakdown.

Figure 8: Cut and Make Cost Breakdowns



Additionally, the way Li&Fung currently works with their customers provides several challenges. Each customer requires their costing sheet to be filled in differently, using different terms and abbreviations to define their order. This makes it nearly impossible to standardize the data and use it for the purpose of deriving a labor value.

4.7 Chapter Summary

In this chapter, the methodology used to evaluate a per-unit fair labor cost was derived and the quantification of its various component parts was addressed. The method used to quantify a fair cut and make value is similar to that established by the Fair Wear Foundation. With this, labor costs can be broken down to the following:

$$Unit\ Labor\ Cost = \frac{garment\ SAM\ \times\ labor\ cost\ per\ minute}{line\ efficiency}$$

This method for quantifying a fair labor value provides the most transparent and understandable labor calculations. The aim of the model is to promote factories who invest in improvements and fair labor. This is done by using Li&Fung's internal vendor data as well as factory level data to establish a factory efficiency. By using independent variables such as vendor social compliance ratings, advanced machinery capabilities, and factory improvement techniques such as lean implementation, factories will have a higher efficiency estimate, which will lower their costs, making them more desirable to work with.

Additionally, it is important to establish and integrate standardized methods to calculate the time it takes to produce a garment. Software such as General Sewing Data (GSD) allow for such standardized methods by using operator motions as building blocks to determine an overall standard minute value to make a garment.

Finally, a fair labor wage rate must be established. This rate must be agreed upon by the factories and laborers/trade unions to help ensure long term adoption. The wage should ensure the health and safety of workers while complying with national wage regulations and ensuring minimum acceptable living standards.

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Chapter 5: Analysis and Results

5.1 Linear Regression to Estimate Efficiency

As mentioned in the previous chapter, there are several factors that contribute to factory efficiencies. By leveraging these variables, it becomes possible to predict a factory efficiency with greater granularity than just country of production. Traditionally, the country of production is the main determinant that drives efficiency estimates, however there are several other factors that can be used to estimate the efficiency of a production batch.

In order to leverage these variables to predict the efficiency of a production batch, a linear regression model was used. Linear regression is a commonly used type of predictive analysis that uses continuous independent variables to estimate the real value of a dependent variable. This relationship is determined via a best fit line amongst the independent variables. Each independent variable has a numerical significance level in its contribution to determining the dependent variable [21]. The linear regression approach aims to answer two questions: (1) do the independent variables used to predict the dependent variable actually hold any significance? (2) which independent variables actually contribute to predicting the dependent variable, and by how much? The "how much" factor is determined by the sign and magnitude of the beta coefficient, as shown in the below equation:

$$Dependent\ Variable = Coeff + \beta_1 \times Variable_1 + \beta_2 \times Variable_2 + \beta_3 \times Variable_3 + \cdots$$

Using linear regression provides the most transparent, easily understood methodology to calculate efficiency. In the linear regression model used for the fair labor costing tool, the dependent variable being predicted is the expected production efficiency of a factory producing a particular garment batch. This method was used to understand efficiency at a more granular level, and can then be extrapolated across all factories to get a more accurate efficiency level based on more than just country of production. Average production batch efficiency is approximately 47% across all countries, however, true production batch efficiency can range from 30% to 80%, so it is important to understand and determine ways to have a more accurate and scalable method of determining efficiency. The independent variables used to predict the difference in average versus actual efficiency are outlined below:

Vendor score- the vendor score is an intricate 0 to 5 point scoring system developed by Li&Fung to assess their vendor base on 5 key metrics across 22 key performance indices (KPIs). The metrics used are:

- Delivery- function of on time shipment and delivery based on several factors including quantity of order as well as cost of order. There is additional consideration for impact the delay has caused
- Production accuracy- measures the percentage deviation of shipment from true order. This measures both over shipment and under shipment
- Social compliance- A through F letter score based on factory social and ethical compliance. This is measured through Li&Fung factory audits as well as 3rd party audit reports and factory certifications. As outlined by Li&Fung, grades are defined as follows:
    - A- factories that may have minor issues for improvement, but are overall compliant with Li&Fung's standards. These factories require a re-audit every 18 months
    - B- factories that have at least one issue that requires improvement. These factories require a re-audit in 12 months
    - C- factories that have at least one substantial issue that requires improvement. These factories require a re-audit in 9 months
    - D- factories that have at least one substantial issue that requires immediate improvement. These factories require a re-audit in 3 months
    - F- factories that have committed a zero tolerance issue as defined by Li&Fung. These factories are ineligible for new business and can be reassessed after 6 months
- Quality- all aspects that relate to the quality of the garment and manufacturing of the finished good, including defect rates during various points of quality inspection. These are traditionally measured as a function of overall quantity of finished goods to number of defective units

- Documentation- measure of shipment document accuracy as a percentage of orders at the vendor level

Manufacturing score- the manufacturing score is a total score based on the manufacturing capabilities of each vendor within Li&Fung's network. The manufacturing score sheds light onto the machinery, manufacturing, automation, and people capabilities. The information used to determine a vendor's manufacturing score was derived from a survey taken in 2016 that asked vendors about their current capabilities and future plans. In this survey, Li&Fung's vendor based was asked about the following key areas:

- Areas of investment for future research/ capacity within the domains areas of fabric, yarn, wash, manufacturing, printing, dye, embroidery, and any other areas
- Amount of investment made in the last 24 months for future capabilities/research areas
- Current fabric platforming capabilities
- Percentage of overall business dedicated to core programs, test programs, and chase programs
- Process improvement initiatives including lean, six sigma, total quality management, value stream mapping, kaizen events, 5s, preventative maintenance programs, visual management, standard time calculations for production planning, or any other initiatives
- Any current use of product lifecycle management (PLM) software
- Any current use of product design and development software
- Any current use of pre-production software
- Any in-factory production real time data tracking methods being used such as RFID, QR codes, barcode tracking, or any others
- Any current use of accounting and finance software
- Any current use of product shipment and logistics software
- Adoption of manufacturing tools and technologies including electric sewing machines, specialized sewing machines such as auto placket, auto pocket, auto collar, etc., whole garment knitting machines, Computer controlled machines such as auto cutters, laser etcher, auto embroidery etc., Other automated equipment such as auto spreader, auto steamer/presser etc., Conveyor system such as an overhead conveyor or conveyor belt,

and any advanced water technology such as "waterless" washing/dyeing, reverse osmosis for water recycling etc.

The survey was initially used to understand current vendor capabilities so that Li&Fung could identify areas to help vendors increase productivity and invest in areas that would produce the greatest impact. This survey also asked vendors about their current technology needs and sources of gathering new information. Although not all information was used from this survey, the answers to the above questions related to factors that drive efficiency were used to create an overall manufacturing score for each of the vendors in Li&Fung's vendor base.

An additional input into the model was order size. The number of units within a production batch effects efficiency due to scalability of an operation. The assumption being that as the number of units increases, the efficiency also increases, and as the size of the order decreases, efficiency decreases.

The dependent variable being predicted in the model is the expected production efficiency of a factory producing a particular garment batch. The country efficiency is determined through calculating the historic aggregated productivity of the factories within the country multiplied by the average absenteeism rates within that country.

$$Efficiency = productivity * (1 - absenteeism)$$

As outlined in the previous chapter, the efficiency of a factory can vary greatly within a country, however industry estimated country efficiency can be a good proxy for understanding worker's skill levels. The independent variables used in the model were the factory's delivery score, production accuracy, social compliance rating, quality score, and documentation score, as well as the factories manufacturing score based on automation capabilities, and the number of units being ordered.

Using a linear regression approach, the model was able to achieve a multiple R^2 of .855 and an adjusted R^2 of .739. The R^2 is a measure for goodness of fit of the model. The adjusted R^2 takes into account the number of variables used to predict the dependent variable and adjusts the R^2

accordingly, as all additional independent variables will increase the R^2 as any new piece of information will help to explain the model. Because of this, the adjusted R^2 penalizes the addition of any additional independent variable that doesn't significantly contribute to the determination of the dependent variable. Given the strong R^2 coefficient, excluding the inherent issues regarding data collection and self-reporting on surveys, there is strong evidence that it is possible to determine vendor efficiency at a more granular level, ultimately helping Li&Fung have stronger, more meaningful negotiations around determining efficiency and ultimately deriving a fair labor value.

5.2 Model Pilot

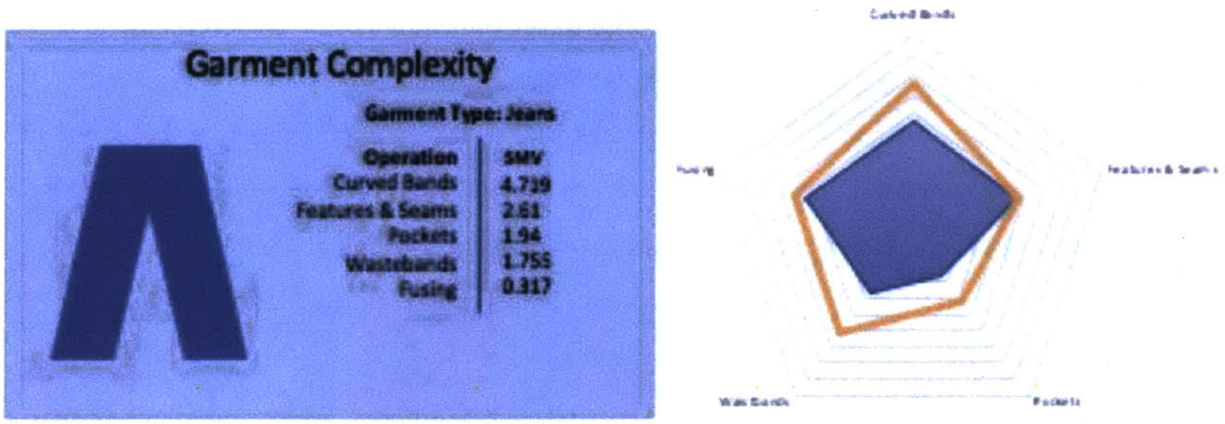
As a pilot for the model, jeans were used as the garment to manufacture. Jeans primarily rely on 5 operations to produce: curved bands, features & seams, pockets, waistbands, and fusing operations. Although jeans can be much more intricate, as a pilot, these operations cover a large majority of basic jeans.

Table 3: Operation Selection of Basic Jeans

Operation	Select Feature
Curved Bands	Curved sinkstitch - square band end ops
Features & Seams	Lining Operations For Keyholed Lining
Pockets	Denim 5 Pocket Taped
Waistbands	Straight band with edge stitching then bandfold
Fusing Operations	FUSE BAND POLY MITRED

As demonstrated in table 3, the model allows the user to select the feature within a dropdown for ease of use. After the selections are made, the user can see the numerical value of the standard minute value to perform each operation as well as a visual that demonstrates complexity of each operation in relation to the complexity of the average operation, as defined by amount of time to perform.

Figure 9: Numerical and Visual Representation of Garment Complexity



Using this method, users can understand what is driving garment complexity and can make informed decisions on what operations to change if they are looking to reduce overall production costs.

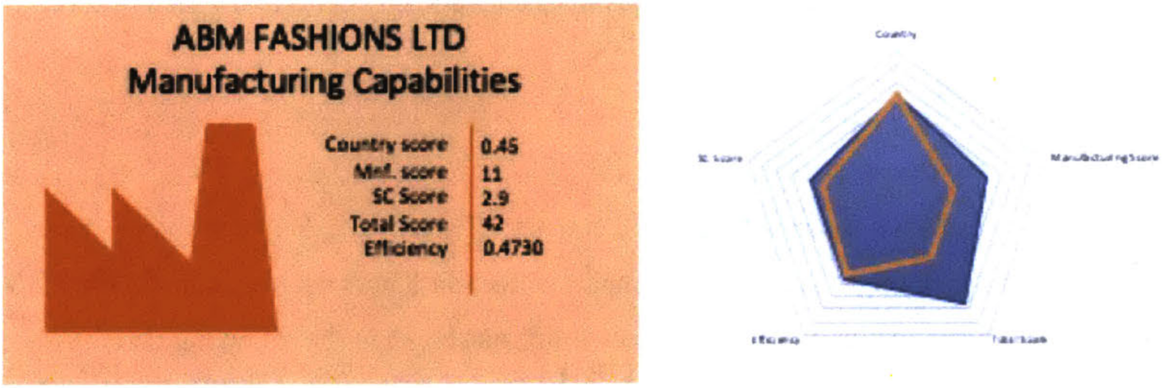
As it relates to the implementation of displaying efficiency within the model, the approach taken was to make all the aspects effecting efficiency as transparent as possible as well as easily understood. Efficiency estimations are generated using a fixed and variable approach. The independent factors outlined above are fixed, while the order size, which is also a large driver of efficiency is variable. For this, the first step is to select the country of manufacturing as well as input in order size:

Table 4: Factory Selection and Order Size Input

Information	Select Choice from Dropdown Below
Select Country	Bangladesh
Select Factory	ABM FASHIONS LTD
Select Order Size	1,200

After a factory is selected, the model will show the user the various components that determine the factory's efficiency as well as how the factory compares to an average factory across all efficiency variable metrics.

Figure 10: Factory Efficiency Metrics



This method ensures the user understands how efficiency is being driven both numerically as well as visually, and can allow users to determine what factories will offer the best value to their customer while still adhering to a set standard for fair labor practices.

After the desired factory is selected, the order size has been input, and the garment operations have been determined, users can see the expected SMV needed to produce the garment based on the selected operations. The model then calculates the efficiency based on the capabilities of the selected factory and produces a fair CM value to manufacture the garment.

Figure 11: Factory Efficiency Calculation and Labor Cost Determination

Time to Produce Garment		11.341
Expected Factory Efficiency		47%
Cost per SAM	$	0.15
Labor Wage ($USD/Month)	$	156.75
Social services from Factory	$	42.31

Fair CM Value	$	1.68

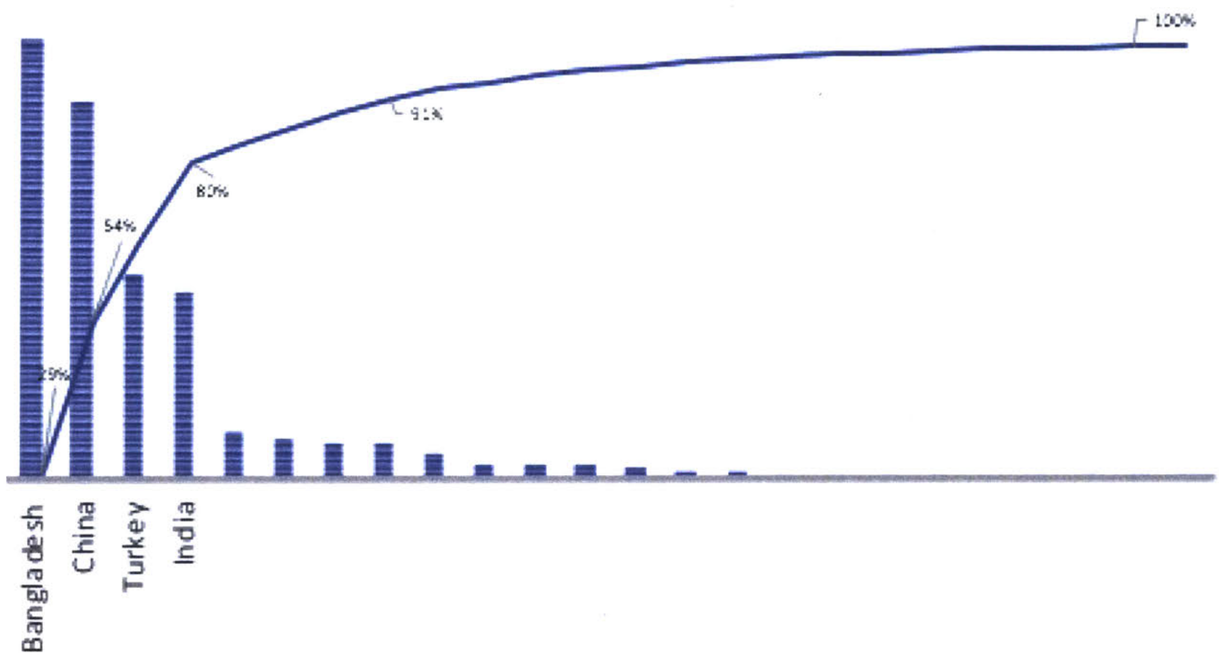
The overall approach taken allows users to understand how each variable effects overall efficiency, and in turn, how the efficiency effects overall cost. This approach also displays what the fair labor wage should be as well as the value of the social services being provided by the factory are. This method, along with in-factory digital payments to laborers, allows for the bridge of overall supply chain transparency as it relates to costing and payments at the factory level.

5.3 Country Analysis

5.3.1 Country Efficiency Analysis

As outlined in the previous section, the average country efficiency plays a large role in determining a fair labor wage. To maximize impact of the fair labor cost tool, it is important to understand the factories which Li&Fung sources from. As shown in the following pareto analysis, the majority of factories Li&Fung sources from are primarily located in Bangladesh, China, Turkey, and India. The Survey conducted in 2016 was extrapolated to the current Li&Fung vendor network in order to determine the manufacturing scores of vendors within their current network.

Figure 12: Pareto Analysis of Li&Fung's Factory Base (based on number of factories)



Based on the available survey data as it relates to currently used factories, the countries used for creation of the model were Bangladesh, Myanmar, Sri Lanka, Vietnam, Cambodia, India, Indonesia, China, Morocco, and Turkey. All of the vendors who responded to the survey are located within these countries, and using these countries as a framework for when additional data becomes available allows Li&Fung to maximize the amount of use that the fair labor costing tool can provide. In determining the average efficiency for each of these countries, it is necessary to first understand the average factory productivity as well as absenteeism, as these are the primary components that drive overall average efficiency. Efficiency is calculated through the following relationship:

$$Average\ Country\ Efficiency = Productivity\ (1 - average\ factory\ absenteeism)$$

For the fair labor cost model, the following table displays the information identified as the average factory efficiencies for each country.

Table 5: Average Production Efficiency per Country

Country	Days per year	Hours per week	Total SAMs @ 500 Ops	Productivity	Absenteeism	Efficiency
Bangladesh	300	48	32400000	50%	10%	**45%**
Myanmar	300	44	29160000	45%	10%	**41%**
Sri Lanka	255	48	27540000	50%	10%	**45%**
Vietnam	292	48	29959200	45%	5%	**43%**
Cambodia	287	48	29446200	45%	5%	**43%**
India	300	48	32400000	50%	10%	**45%**
Indonesia	289	48	36240600	55%	5%	**52%**
China	270	48	34992000	60%	10%	**54%**
Morocco	250	48	35100000	65%	10%	**59%**
Turkey	238	45	35985600	70%	10%	**63%**

The average productivity and absenteeism rate of factories within a particular country are found through local factory data and regional sourcing offices. As noted in section 4.4.1 *Traditional Methods for Calculating Efficiency*, the actual determination of efficiencies within a factory can only be done post production and are based on the factories that report their efficiencies, as well as independent studies done by both Li&Fung and trusted third party verifiers. With this information, an average can be determined.

Another important point to mention is that the average for an entire country may not be the best representative to the average for each region within that country as factory capabilities and availability of skilled laborers can vary greatly per region. As an example, an analysis performed by Technopack [22] shows the variation of efficiencies of garment manufacturing within different regions of India.

Table 6: Average Production Efficiency within India

Region / Cluster	Efficiency
Delhi / NCR	36% - 42%
Ludhiana	40% - 45%
Bengaluru and Chennai	40% - 45%
Tirupur	42% - 50%
Average Indian Factory	45%

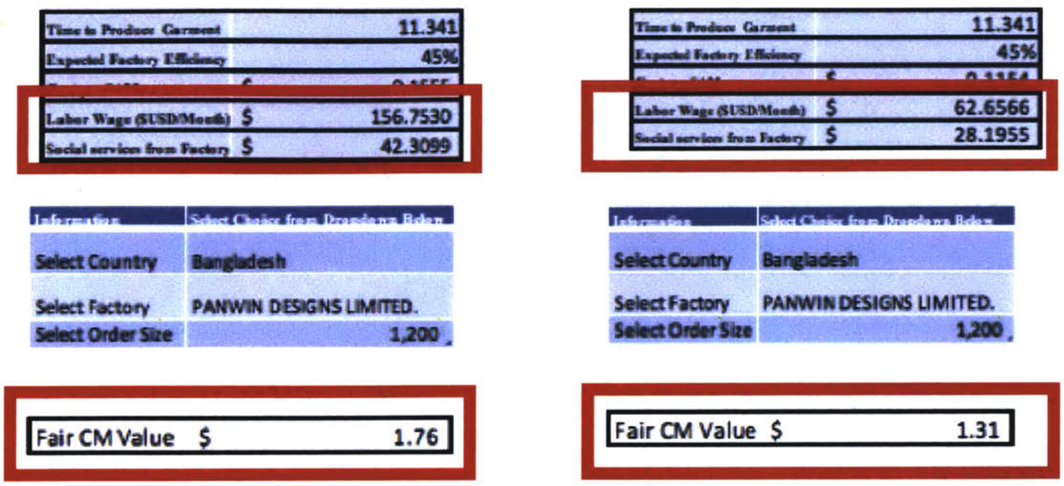
For the sake of the model, average regions per country were aggregated, however, as more reliable data becomes consistently available, the roadmap of the fair labor cost tool will include providing additional granularity on a per region of country basis.

5.4 Fair Labor Impact Example

Using the approach outlined, 59 active factories within Li&Fung's network were analyzed based on the self-reported survey results. The main area of interest was determining how increasing the wages paid to the laborers would effect overall garment FOB cost. As an example, the model was used to determine the cost to make jeans in a factory in Bangladesh. The resulting changes to labor and production costs are shown in the following figure.

Figure 13: Effects on Production Cos Based on Labor Rate

Labor Rate that meets Union Demand | **Current Labor Rate**



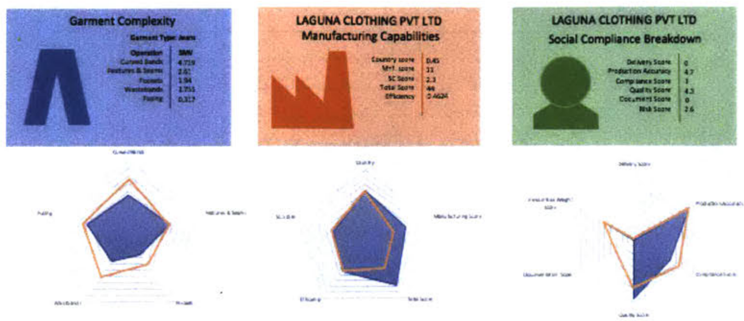
Assuming an average order size of 1200 units in an average factory in Bangladesh, it was determined that it is possible to raise the pay and social services provided by the factories to the workers by nearly 200% while only raising the cost to produce each jean by less than $.50.

5.5 Effects on Price Based on Factory Automation Capabilities

The additional effect of this model is to promote factories who are investing in their people as well as in automation. As this model takes into account social compliance ratings alongside automation capabilities to determine efficiency, it stands to reason that factories who comply with Li&Fung's guidelines for quality work standards will prove to be more efficient in producing garments, thus lowering the manufacturer's cost to produce with that factory. As an example, two factories in India were analyzed to determine the cost to produce the same garment, shown in figure 14.

Figure 14: Comparison of Two Garment factories

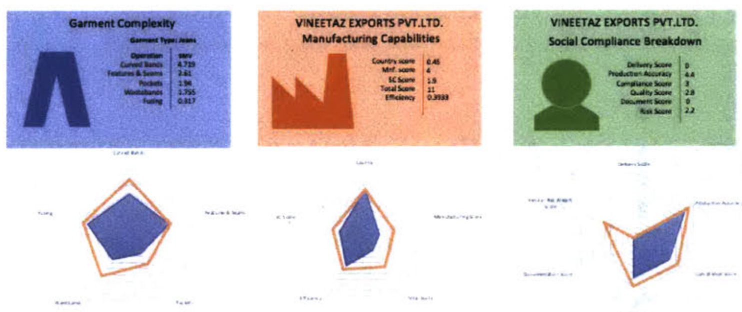
Factory A:



Time to Produce Garment		11.341
Expected Factory Efficiency		46%
Cost per SAM	$	0.15
Labor Wage ($USD/Month)	$	124.05
Social services from Factory	$	37.21

Fair CM Value	$	1.72

Factory B:



Time to Produce Garment		11.341
Expected Factory Efficiency		39%
Cost per SAM	$	0.18
Labor Wage ($USD/Month)	$	124.05
Social services from Factory	$	37.21

Fair CM Value	$	2.02

As shown above, factory A has greater automation capabilities as well as overall better quality score than factory B. As both of these factories are in the same country producing the same garment, the time to produce the garment as well as the labor wage paid out are both the same. However, it is 15% cheaper to produce a garment with factory A due to their increased efficiency.

Chapter 6: Recommendations and Conclusions

6.1 Practical Considerations

As eluded to in the previous chapters, the success of this methodology and implementation of this tool relies heavily on all of the decision makers across the entire supply chain. There is a large amount of trust and transparency required in each step, with agreements that must be made between the manufacturing vendors, Li&Fung, and the brands at each step. The following considerations must be met in order to ensure a successful implementation:

- When establishing the standard minute value to produce a garment, trained and experienced GSD users must verify the accuracy of the stated SMV. This is critical in determining the accuracy of the expected labor required to produce the garment.
- All relevant parties must have a voice in determining a fair labor wage, including the laborers and manufacturing vendors. Although there are several organizations who work to determine fair labor rates, it is difficult to establish at a very granular level, and the needs of workers on a factory to factory basis can vary tremendously based on location, proximity to work, family size, etc. Having labor unions in place can help determine what an accurate labor wage is, and can work to negotiate with the manufacturing vendors, where Li&Fung can act as a mediator. Additionally, laborers must also receive relevant knowledge on how their wages are being determined, including how position and skill level play a role in determining wages.
- Payments to the workers should be based on hours worked and should be digitized to ensure that wages are actually being paid out. Digital payments is currently an initiative that Li&Fung is working to roll out across their vendor base, and these factories should be the starting point for using the fair labor costing tool. By establishing worker's pay using time as opposed to piece wise, the burden of stoppages outside of their control such as machine breakdowns is relieved.
- Consistent and standardized methods of collecting data must be available in order to ensure the accuracy of a factories' efficiency. Factors such as employee absenteeism, machine availability and downtime, and skill level of employees change on a day to day basis. For the sake of the model, an aggregate was taken, however, as technology

evolves, having a consistent and standardized stream of data will enable accurate efficiency calculations. Li&Fung is currently working on projects to create consistent data streams including RFID projects, QC defect trackers, and sensors on machines. These type of projects will provide tremendous value in ensuring up to date factory information that can be used to more accurately quantify efficiency.

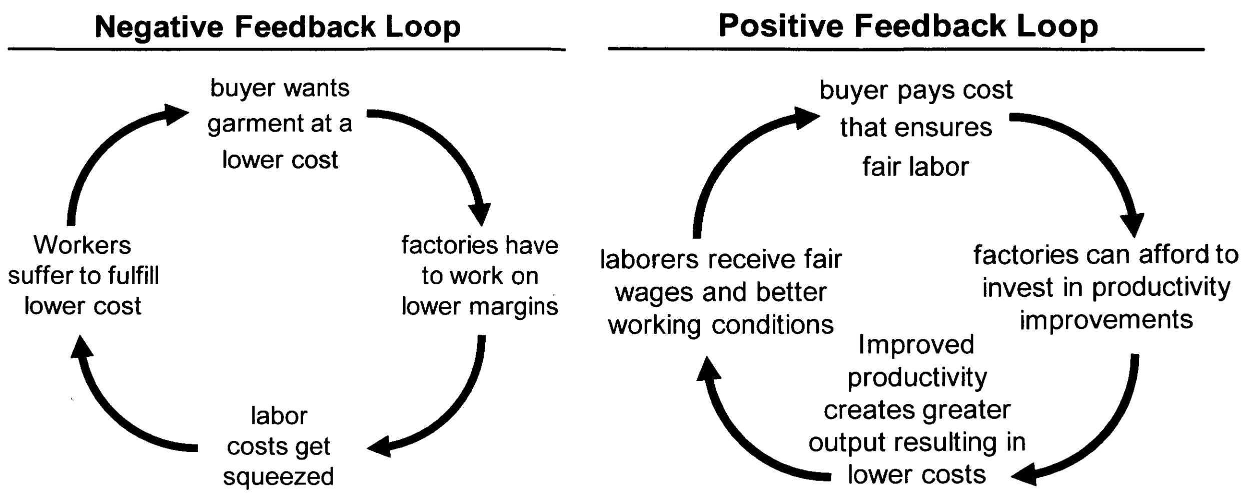
Understandably, many brands and manufacturing vendors are nervous about collaborating around pricing and production costs as this can potential create issues related to competition or anti-trust laws. Additionally, factories are hesitant to invest in new technologies as they are not guaranteed contracts, so they are unsure if they will have enough return on invested capital. These can be worked through via contracts and intermediaries, such as Li&Fung, who can help to mitigate these fears and ensure successful collaboration and guaranteed work to factories that meet high production standards.

6.2 Benefits of Implementation

"The idea of a responsible supply chain is really simple: 'My dollar should not go to anyone who's profiteering off of slavery or worker exploitation or destroying the environment.' But the reality is so much more complex." Greg Distelhorst, a professor at MIT Sloan School of Management eloquently sums up the consensus of everyone who believes in operation within an ethical supply chain. As Li&Fung looks for alternate ways to serve their existing customer base while simultaneously attracting new customers through service differentiation, the fair labor costing tool can prove to be a valuable step in establishing a "fair trade" option to their customers who do not have the supply chain knowledge to do so themselves.

The feedback loops of the current state of production as well as potential future state of production is illustrated in the following figure.

Figure 15: Feedback Loops for Garment Production



Currently, as buyers look to produce a garment, a common fixture is reducing costs as much as possible. This causes factories to operate on much lower margins. As the demand to produce the garment faster and cheaper increases, additional unforeseen costs start to be incurred such as excessive garment defects, equipment failure, etc. The additional time and labor required causes the laborers to work additional amounts of time that they may not be compensated for.

Alternatively, if a fair labor costing method is implemented, buyers will pay a per unit price that includes a complete breakdown of all cost components including a quantified labor value. This will then allow factories to pay their workers an adequate compensation as well as invest in technologies and procedures that will increase productivity. These product improvements will result in lower defect counts as well as higher production outputs. This will ultimately help to lower the overall cost of production, as increased efficiency results in lower costs, as shown in figure 14.

As a trial, a brand can agree to do one production batch using the model as a basis for establishing a fair trade price. As noted in figure 13, a 188% increase in salary to a laborer in Bangladesh resulted in a $0.45 increase per unit. If a brand were to produce 1000 units of a standard pair of jeans, it would cost them an additional $450 for the batch to use fair labor pricing. If they were to increase the cost of their jeans by $1, negating increased costs incurred related to marketing and assuming a direct pass through of the increased cost on the final retail price, they would have the ability to make an addition $550. Both stated and revealed preferences have shown that customers are willing to spend more for sustainably sourced garments [23]. Through this tool, brands will have the ability to reach new customer audiences.

6.3 Factory Survey Assessment

As outlined in the previous section, the information used in the efficiency calculations for the model were adapted from a 2016 survey. Moving forward however, in order to determine the internal factors that determine a factory's efficiency, there are several additional key areas that should be analyzed. This new method will simplify the previous survey and instead focus on three primary areas to determine the baseline level of a factories efficiency. The three areas are as follows:

1. General factory data-

The factory data allows Li&Fung to determine the scale of the supplier's operation as well as understand some of the endogenous factors related to efficiency such as absenteeism and labor turnover. Additionally, through this data it becomes possible to estimate the amount of standard allowable minutes (SAM) available to produce a garment based on:

$$SAM\ available = \#\ of\ direct\ employees \times (basic\ weekly\ hours + average\ overtime\ hours) \times (1 - absenteeism) \times efficiency \times 60$$

This allows Li&Fung to do a quick and accurate back of the envelope calculation to determine if the factory they are considering has the capacity to deliver on an order depending on the size. An example of such a calculation can be shown in the following figure.

Table 7: Estimated Weekly Output of a Factory

Supplier Name	Total Turnover	Number of Factories	Locations	Total Employees	Direct Employees	Indirect Employees	Ratio
Open-Ended Response	Open-Ended Response	Open-Ended Response	Country/Region	Open-Ended Response	Open-Ended Response	Open-Ended Response	
Supplier X	$22,000,000	2	Bangladesh	1500	1000	500	2 : 1

Basic Minimum Weekly Wage	Basic Weekly Hours	Average Overtime Hours	Absenteeism %age	Labour Turnover	Bonus Structure	X	Does your company own any of the following facilities?	X
Open-Ended Response	Open-Ended Response	Open-Ended Response	Open-Ended Response	Open-Ended	None		Farms for raw materials (e.g., cotton or silk farm)	
					Factory Bonus		Spinning mill	
					Team Bonus	X	Weaving mill	
$65	48	8	10.0%	35.0%	Individual Bonus		Dye factory	
							Trim manufacturing	
							Label manufacturing	
							Carton factory	
							Laundry	X
							Embroidery factory	
							Digital fabric printing facility	
							Product/material testing lab	X
							None	

Direct Hours Available	50,400
Estimated Efficiency	55%
Weekly SAMs	1,663,200
Estimated Product SAM	15
Weekly Output	110,880

2. Production Systems-

The second area in determining factory efficiency assesses the production systems within the factory. This allows us to understand the current state of the factory in terms of what their operational efficiencies are as well as that their future plans are. As outlined in the following figure, the current state of a factories lean implementations are assessed, as well as their IT infrastructure. These questions are key determinants to a factory's current potential efficiency as well as their potential future state.

Table 8: Production Systems Assessment

Lean initiatives	Six Sigma intiatives	Total Quality Management	Value Stream Mapping
Not Implemented	Not Implemented	Not Implemented	Not Implemented
Implementation in Progress	Implementation in Progress	Implementation in Progress	Implementation in Progress
Already Implemented	Already Implemented	Already Implemented	Already Implemented
Planned for future Implementation	Planned for future Implementation	Planned for future Implementation	Planned for future Implementation

Kanban (signal for inventory replenishment)	Kaizen events	5S	Program for Preventative Maintenance (machinery)
Not Implemented	Not Implemented	Not Implemented	Not Implemented
Implementation in Progress	Implementation in Progress	Implementation in Progress	Implementation in Progress
Already Implemented	Already Implemented	Already Implemented	Already Implemented
Planned for future Implementation	Planned for future Implementation	Planned for future Implementation	Planned for future Implementation

Visual management (displays with performance metrics on production floor)	Do you use Product Lifecycle Management (PLM) software?	Which software(s) do you use in Production?	Calculation of standard times for payment/production planning	calculating time it takes to make a garment
Not Implemented	Y/N	RFID tracking	Not Implemented	none
Implementation in Progress		Barcode tracking	Implementation in Progress	observation
Already Implemented		QR Codes tracking	Already Implemented	stop watch
Planned for future Implementation		Other	Planned for future Implementation	synthetic data (GSD)

3. Manufacturing Process

The third area used to assess factory efficiency is through exploration of the manufacturing process. As detailed in the previous chapters, automation capabilities within a factory play a large role in determining the overall efficiency of that factory. For the manufacturing of jeans, there are three primary areas of automation: Cutting, machining, and finishing.

The cutting operations can be very capital intensive, and without automation can result in a lot of excess waste and defects. The cutting operations are traditionally the first to be automated. Within the cutting room, the inbound rolls of fabric should be tested for defects, and then laid out and marked for cutting. Once cut the pieces begin the process of being fused together and bundled for assembly. Each of these processes has the ability to be nearly completely automated depending on the factory.

Table 9: Operations Within the Cutting Room

Cutting Room						
Rolls of fabric tested for	Markers	Spreading	Laying-Up	Cutting	Fusing	Bundle Integrity
shrinkage	Manual patterns	Manual	one way	straight knife	manual	shade batched
shade	paper markers	manual cart	lap lay	band knife	conveyor	hand marked
useable width	digitized e.g. Gerber	motorised cart	other	automatic e.g. Gerber	other	Soabar
	other	automatic spreader/cutter		other		other
		other				

In determining the efficiency of operations within the machine room, several key areas need to be explored, including how the manufacturing process is done, the handling system that moves the work in progress around the factory, how process control and quality control are done, as well as what types of machinery, both regular and specialized, is available. Additionally, as it relates to jeans, it is very important to understand how the finishing is completed, as certain features such as faded jeans or a "warn out" look can be very time intensive.

Table 10: Machine room and Finishing Operations

Machine Room						Finishing		
Manufacturing process	Handling system	Process Control	Quality Control	Machinery	Specialised Machines	Laundry	Special Finishes	Environmental controls
inline	Progressive bundle	manual recording	Inline	basic	Auto pocket hem	on site	brushing	
teams	trollies	work tickets	end-of-line	hand scissors	auto belt loop	machines – manual or computerized	whiskering	
pre-assembly/assembly	clamp trucks	computer control	traffic lights	helpers	auto pocket attach	effluent treatment	bleaching	
other	single unit	other	other	auto-backtack/UBT	bandfold machines	other	other	
	TSS system			top/bottom feed	other			
	Eton system			sensors				
	other			other				

6.4 Chapter Summary

Several key factors are needed in order to ensure the successful implementation of the fair labor costing tool. These factors include:

- Ensuring the standard minute value is accurate through using certified GSD practitioners

- Labor wages must be agreed upon by both the laborers as well as the manufacturing vendors in order to ensure a sustainable partnership
- Payments should be paid on an hourly basis as opposed to piecewise and payment processing should be completed digitally to ensure accurate payments are being made. Workers should also be adequately informed about how their pay is being established.
- Data collection has to be a top priority in order to continuously determine an accurate factory efficiency value as this is critical in determining a fair labor wage

There are several additional concerns that arise from both the brands as well as the manufacturing vendors. Problems related to competition laws and consistency of receiving work are warranted, but can be mitigated through third party companies such as Li&Fung, who have extensive factory networks and brand customers. Li&Fung can leverage this information to establish objective policies that are mutually beneficial to all parties.

The successful implementation of the fair labor costing tool will help not only laborers earn fair wages, but also help factories be able to invest in productivity improvements as well as allow brands to reach new consumer demographics. As the desire for more sustainably sourced goods increases, Li&Fung is in a unique position to help fill the gap through their extensive supply chain knowledge and supplier network.

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