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Chapter 7: Developing personalized finance tools for income management, savings optimization, and budgeting

7.1. Introduction

In today's world, finance is an essential aspect of daily life. The flow of money is a requisite for survival and almost all individuals must make income, budget or savings related decisions every day. Given these keystone aspects of most people's lives, tools that alleviate some of the costs associated with these tasks should be incredibly popular. However, the personal finance tools available suffer from a number of deficiencies that seem counterintuitive given how broadly applicable they are. Most commonly used financial tools such as low-interest rate checking and savings accounts have not changed in many decades; home equity loan or credit card products involve high interest rates that are not available to many individuals; short and long-term savings accounts, retirement funding tools and checking accounts rarely pay any interest at all; and most budgeting software tools are tedious to set up and require frequent oversight and tweaking to maintain. Moreover, the tools are not widely utilized. An estimated 40% of households have no savings and omit savings from their budgets; the average credit card debt is about 9000; and 67% of Americans rely on financial institutions for loans with an average interest of 36% (Al-Aqrabi & Hill, 2019; Anderson & Taylor, 2021; Jain et al., 2022).

Although people of each demographic tend to allocate their limited financial resources in the same way, individual budgets differ widely. Societal attributes, such as ones' place in the industrialized western world, and personal attributes, such as family structure, age, idiosyncratic preferences, level of financial and technical expertise and other hedonic, utilitarian or security considerations dramatically affect the allocation of specific budgetary items. These differences necessitate different budgeting and savings optimization solutions, which indicate the funds available for different kinds of expenditures, or enable people to dedicate all available funds to specific categories during the budgeting process. In the case of expenditures with a frequent high visibility, like food, accommodation or travel, many individuals and families can more easily set aside some funds on a daily, weekly or monthly basis (Li & Ramanathan, 2022; Chen & Zhao, 2023).

7.2. Understanding Personal Finance

Personal finance, broadly speaking, refers to the management of an individual's finances, such as earnings, expenses, savings, and investments, and is a discipline that can help you make informed financial decisions. Gathering money and spending money is a familiar occurrence. After gathering a certain amount of wealth following a job change, promotion, or alternative opportunities, the burning desire is to spend it all on buying items and experiences that lead to a more pleasurable life. After working hard for many years, a great deal of money is accumulated. One should know how to properly utilize those funds for particular time periods: for today's consumption, future consumption, or some mixture of the two. The fact is, improper personal financial decisions can undermine the individual's health and well-being. Without proper management of personal finance, an individual may not be able to cover unexpected expenses today, left only with the option of increased dependency on credit tomorrow. Additionally, one could face the severe risk of having an insufficient amount for retirement, perhaps spending the last decades of life in poverty. Recent research has confirmed that making sound financial decisions can promote success both today and in the future, while poor decisions can have negative consequences. Therefore, personal finance is an essential skill in leading a successful life.

A critical step in understanding personal finance is being financially literate. Financial literacy is the knowledge and understanding of financial principles and concepts. A financially literate individual understands basic skills such as budgeting, saving, and investing, and is able to apply them in life. People also need to know the principles and concepts behind these skills, such as how credit card offers and interest rates work or how investments vary in return and risk. This knowledge can be obtained by personal experiences, simply observing the financial decisions of others, or receiving formal training through classes or community programs.

7.2.1. Definition of Personal Finance

The term personal finance refers to the management of finances of a natural person or a family. However, this simple definition needs to be expanded and refined. The term personal finance did not originally include the non-business aspect of a family. Some definitions show the serious scope of the term. Personal finance encompasses the financial decisions and activities of an individual or family unit, including budgeting, insurance, mortgage planning, savings, and retirement planning and saving, and covering taxes. However, the term personal finance is more than just financial decision making. Financial and money decisions of an individual are personal in the sense that they are not taken collectively, as is usually the case with businesses. While corporate finance deals with creating wealth for the shareholders, personal finance focuses on the creation of wealth, sharing of income, and allocation of resources over time, for both consumption and investment through a person's life cycle. It also includes saving for short-term, such as vacationing, and for long-term goals, such as retirement, along with acquiring and maintaining financial security, such as insurance against uncertain future events.

Fig 7.1: Financial Management Systems

Considering these definitions, it is clear that personal finance is a multi-faceted area. It includes how you accumulate and control your financial resources to obtain and maintain financial security and independence. A rule of thumb for healthy personal finance is to live within your means, plan for the future, and guard against financial surprise. While it is possible to understand and practice good personal finance without formal training, such knowledge and training will enable you to make better-informed and more thought-out financial decisions at crucial points in your life, for example, when you are about to become a parent, change jobs, or retire.

7.2.2. Importance of Financial Literacy

I've shown that financial literacy has beneficial effects on personal income, consumption, saving and investment decisions. As a consequence, financial illiteracy lowers living standards. In previous sections we discussed financial literacy as an initial condition of personal finance. In this section I review the literature on personal finance education.

Living in the modern world requires a certain degree of financial literacy. Financial decisions are constantly being made, such as: how much money someone will receive for his or her first job and how much of that money will be put aside for retirement; how a college student will shift his or her income stream from borrowing money to earning it; how a young professional family will manage the income, the debt, and the adjustment while having a baby; how a career retiree will allocate his or her savings into a monthly retirement payout, investments that are usually income-generating, and a possible reverse mortgage; how a young traditional or nontraditional family will manage income and expenses, saving for children's college through different investment vehicles, mortgages, alternative investments, while both caring for aging parents and still in the work world, and how likely they will be to implement these financial plans; how a retiree will manage the complex, multigenerational demands of a family while adjusting to circumscribed income. All of these decisions hinge on a certain level of financial literacy, either held by the individual or provided by a knowledgeable friend or advisor.

7.3. Income Management

The income management component of personalized finance tools allows individuals to manage both their recurring predictable income and their ad-hoc unpredictable income flows. Income management includes functions such as income tracking and income allocation. For many customers, income management tools may be the most complex components of their budgeting or financial planning systems. Individuals may lose out or lag behind other investors who effectively employ a buy-and-hold for the short term, and take advantage of select industry sector or micro cap or small cap investments. In the short-term, it is difficult to manage these competing income desires of having enough to invest selectively, plus having enough liquid income to service ongoing expected and unexpected costs and expenses.

Income management allows for all these competing goals to be tracked, and the goals adjusted, using current day-of-the-week and time-of-the-month and time-of-the-year calendars for percentage of income and percentage near-term budget spending. There are rules of thumb and customary prudent guidelines to use, but ultimately each individual family unit is on their own. Simply tracking input or flow after-the-fact is not enough, especially for those adamant proactive planners. So we start by tracking input after-the-fact but have a more real-time or forward-looking budget for expected flows with the concept of having prepaid anticipated short-term cash withdrawals or expenses as well as accounting for the very next anticipated inflows and the down-to-the-nickel estimation of charges and expenses that will reduce bank account balances relative to income balances.

Once it's clear that tracking all of this activity is a full-time job requiring keying in much data, we can consider the alternative that the bank, credit card and investment trading account websites already maintain all of this data electronically. That cuts down on what is need to be done subsequently. But just because it is electronically stored or in files out there doesn't mean the data is available at your computer's fingertips. Or the accurate and meaningful accounting information that connects both the input and output forces from your cash flow, income and balance sheet perspective are readily available in user-friendly manner and available for forward-looking goal setting.

7.3.1. Income Tracking Methods

Because personal income fluctuates over short to medium time scales, understanding the flow of income over time can be complex and difficult. A side effect of tracking income is that it can also show when irregular payments arrive, important both for knowing how much you have available but also for budgeting around those events. These payment histories have value beyond just the destination account, though. For people with irregular income, having a history of deposits can help show likely lenders that they are good credit risks, and the quality of those histories can affect how much banks will offer for loans or the interest rate charged. Many factors go into choosing an income-tracking method, including payment mechanics, fees, available records, and tools used. In this section we will consider three basic methods of tracking income: accounts used for non-bill expenses, calendar logging, and bank statement monitoring.

Most income tracking methods use information from a primary checking account on which salary payments are made. Users tend to rely on their primary account to fund all non-bill payments, so that analyzing statements reveals the incoming and outgoing transactions. If a primary account is used exclusively for income-related transfers, observing the frequency, amount, and duration of those transfers is easy. Unfortunately, the costs of maintaining just one account can be too high, and few users actually make only income-related transfers. Certain accounts used non-exclusively will be subject to fees that can render this approach infeasible. However, many people keep multiple checking accounts; there are limited or no fees for many of them, and deposits into these secondary accounts tend to be income related. By observing income flows into (or perhaps transfers among) these accounts, periodic income can be captured. Again, fees and other restrictions may make this option unusable for some users.

7.3.2. Income Allocation Strategies

As mentioned in the introduction, tracking one's income is a basic requisite to develop relevant income management, savings optimization, and budgeting tools. The tracking of one's income by job appointment types distinguishes between wages, profit or loss from self-employment activities, rental income, investment dividends, pensions, interest from bank deposits, and royalties. The income allocation, budgeting and savings tools developed are done on a combined basis modeling jointly recurring expenses and savings in an integrating classified payments calendar based on cash flow nature and timing and allocating cash flows to their categories, with different target balances per category, at the dates of cash flows and savings recurring periodically on their pay dates. They are also done without using or needing a sanitization procedure for cash flow itemization. How can income be allocated to a category for its savings target balance to be set while money is not yet supposed to have reached the individual's bank account?

In order to allocate income to an expense category, monthly estimates of the category amounts have to be made from a historical database consisting of past accounts activity classified by expense category. These monthly estimates of the timing of expenses are required for salary income, rental income and proceeds from corporate dividends, not for the other types of income. Maximum positive points saved in advance for direct deposit by direct deposit assignment are to be only from these sources. For them, it is possible to receive the relevant amount directly and no cash flow allocation for that income type is necessary. For non-direct-depositable income, an estimated periodic allocation by source of income has to be made. The budget progresses by allocating income to the expense itemizations consequently. When allocation is not possible, expenses have to be cut or income increased.

7.4. Savings Optimization

Savings represent future spending for both discretionary and necessary purchases. However, adults and complementary family units do not usually save enough money, relative to the multiple short-term, medium-term, and long-term goals, to fulfill desired immediate consumption expenditures or cushion the negative effects of transient income declines. Money and income management and budgeting tools may facilitate, but by design are not incentivized to encourage, savings optimization. Redirecting attention from current consumption to future cash flows requires a personal paradigm shift, as does trusting more in mathematical calculations than in psychic consumption benefits derived from current spending. Key savings optimizations include designing specific savings goals, determining how to redirect funds from urgent to important areas like savings, automating transfers to help realize goals, and seeking help with the establishment of baseline parameters to enhance commitments to buffering behavior.

A simple rules-of-thumb approach about short-term goals of a week or less, medium-term goals of a month or two, and long-term targets of a year and longer can be helpful. Then, if a salary is incurred, helpful budgeting software facilitates allocation fraction parameters for savings and automating funds transfer to dedicated high-interest savings accounts to ensure achievement of goal amounts within desired timeframes. Since savings for separate goals can be placed in separate accounts, using an automatic transfer schedule based on timing definitions shared by cash outflows for the goal is particularly useful. Savings goals can also provide fun motivations.

7.4.1. Setting Savings Goals

Income is not simply a financial endpoint – it is a financial enhancement tool that helps people accomplish other goals such as spending, saving, investing, and donating. When discussing retirement, education, vacation, and large purchase spending, many potential investors are actually considering how and when to draw on their savings. These are specifically savings goals and they are part of a larger pattern of use and interrelationship for short, intermediate, and long-term objectives all connected into a total financial planning package. Of the three components of basic finances – earning, spending, and saving – saving is unique. Only saving is going to help meet the other goals. Therefore, saving from current income plays the most important role in the total pattern, ultimately determined by personal choices, social heritage, and life-cycle considerations.

Goals not only shape the savings choice, the choice shapes the realization of the goal. The personal investor will have many savings goals at any time – retirement with its influences from work, desire, and social security or pension fund, the college education of the children, preparing for the first vacation or the second or the third automobile, buying the home or improving the beauty parlor or the Winnebago for traveling the country, starting or expanding the business, or planning for that special present to be given on the 25th wedding anniversary. All are competing for a share of available savings in the face of daily spending needs. Since no one is born knowing how to save for these many goals, who better to help than the financial planner? In assisting clients, the financial planner can suggest various planning tools related to goals for learning and capital accumulation.

7.4.2. Automating Savings

One of the biggest roadblocks to successful saving is that it can feel very challenging and sometimes overwhelming to be successful. Furthermore, most of us have a long list of priorities every day and following a savings routine can sometimes fall by the wayside, especially in times of difficulty or great need. In the early days of personal technology, financial historians pointed out that banking on your personal technology could take a lot of the hassle out of the process. Automated savings is the ideal way to help ensure your savings goals are met without the need to remember each month, or to feel the burden of setting aside the money for savings. If we can make something effortless or habitual, then it can help us stay in line with our longer-term ambitions without the extra thought or effort involved.

We tend to prioritize our bills, debt payments, and regular expenses naturally. Perhaps it was how our parents trained us to handle money, with an emphasis on paying what we owe, that making sure our obligations are settled and on time is just embedded in our routines. But automating our savings is a crucial next step in the process, helping our long-term financial goals. What is less obvious is attention to our future selves. It is very natural and easy to spend everything we have. Before modern life, this practice was more about seasonal shifts and cycles. The process of agricultural economy would dictate necessary excesses, providing food for winter, but trigger deprivation changes during the warm months. Mechanisms of habit were simpler to enact for early humans than it is for modern workers. How can you set your intentions to ensure that your future self stays on track, and avoid waste and overspending?

7.4.3. Emergency Fund Essentials

Emergency funds serve the critical function of instantly launching an insurance-like function. In any case when the fund is called upon, it protects against the need to borrow money when income is interrupted or other expenses are incurred. The expenses of having to borrow are severe—especially considering that interest rates families will pay for borrowed funds will be much higher than the interest earned on typical savings accounts. Thus, most experts agree that families should have an emergency fund sufficient to cover at least several months' expenses and, ideally, provide enough coverage for as long as the income disruption or unusual expense lasts. The problem is identifying these amounts since family expenditures tend to be lumpy. How many months' worth of expenses should you have saved? Experts agree that the absolute minimum is three, encompassing the average time in unemployment for most people. But during periods when unemployment is unusually high, this response time can lengthen considerably. New research shows that the cost of a jobless spell can be staggering—nearly two years with a lossing a total of about half a million dollars. The longer the anticipated duration of a jobless spell, the larger the emergency fund should be. Educated professionals enjoy relatively easy and fast access to new jobs offering comparable salaries, but for the less educated, and especially for some minorities, the wait for a new job can be long. If you lose your job or suffer work interruptions regularly, you should save even more. Even if you have never lost your job before, it's wise to set aside a little extra—it could be a long time before you find another one.

7.5. Budgeting Techniques

Creating a budget is a daunting task for many. If we fail to achieve a balanced budget, we try to avoid our displeasure. Despite that, a budget is an indispensable financial tool. This chapter presents some important budgeting techniques. To help ensure sufficient funds to allow you to live a comfortable life while saving enough to avoid financial distress during retirement, most of the techniques presented here require you to first pay yourself and then only spend what's left.

You may find the requirements a tedious chore, and only a determined effort can pull together sufficient information to accurately prepare a budget. Automated budgeting apps can help by cutting down the time required to sift through all your spending to find the expenses to categorize. Automated tracking also makes the task of reviewing your budget easier. Consequently, for those who desire to follow the budgeting proposition but may be reluctant because the monitoring task is too time-consuming, automated budgeting apps make this task easier, allowing them to realize the benefits.

Originally devised for businesses, this method also works for individuals and is probably the most precise budgeting method available. It requires you to estimate every expense you might incur, preventing you from forgetting about hidden expenses that sneak up on you. For example, we often tend to forget about expenses like gifts that come around only once a year. Once you start budgeting, the process can be very helpful in tracking your spending and keeping your financial house in order from year to year. It works best the first year, especially since there are generally life events which can throw your finances into disarray, such as a change in jobs or marriage.

7.5.1. Zero-Based Budgeting

Zero-based budgeting could serve as an effective budgeting tool in the hands of software users familiar with how it works, or willing to invest the significant time and effort needed in order to implement and follow it. It has many positives associated with its implementation, including: assisting users in identifying and eliminating unnecessary spending, and increasing awareness of the tradeoffs associated with every expense. In its most basic form, it requires users to calculate both their total revenues and total necessary expenses, with the goal of ensuring that the two sums equal zero. If total expenses exceed total revenue, users may begin to experience, or worsen, financial distress because of excess spending. In contrast, if the total revenue exceeds total expenses, users have excess non-employment income that could be also allocated among various financial goals. For users whose total revenue significantly exceeds total expenses, it offers a framework for users to explicitly allocate excess non-employment income toward various financial goals, including building wealth through investing, charitable giving, fun spending, or reserves for one-time expenditures such as vacations.

The strength of this budgeting concept is also its greatest weakness. Implementing it implicitly recognizes that making decisions while considering all of the relevant alternatives is important. But in our fast-paced lifestyles of multiple competing demands for time and attention, we have a tendency to make many decisions in a semi-automatic way, as a by-product of habits developed over a lifetime. And this tendency is not conducive to a detailed budgeting process where users are expected to consider all relevant alternatives not only on an annual basis, but for each separate month throughout the entire year, maximum and minimum, whose sum must equal zero. We believe that since implementing it has limited net advantages even when it is possible to regularly micromanage all budgeting decisions, not maintaining an adequately structured yet simple personal finance system may be worse than not doing it at all. Would-be budgeters would benefit from some combination of available user-friendly multi-function personal financial software, and specific advice to do less than a user-on-the-line budgeting approach.

7.5.2. 50/30/20 Rule

The 50/30/20 rule is a simplified model that states that 50% of after-tax income should go to needs, 30% to "wants," and the remaining 20% to savings. Applications of this approach undoubtedly require more detailed tracking of expenses related to needs, wants, and savings, compared to zero-based budgeting. Interestingly, the theory makes no mention of the treatment of seasonal variation of major expenses and income, although its explicit assignment of savings to a percentage of after-tax income is reminiscent of certain budgeting techniques.

As for many techniques, criticism has been raised regarding the percentages proposed. Setting the wants budget to 30% of remaining income is likely too little for affluent households and too generous for some others. Results have shown that a spending split of 75/10/15 is likely to be best for mostly employed households earning an increasing income stream. Lower percentages for savings might help those who do not feel the need for strong savings. Additionally, the method's broad categories render it easy to use by beginners.

7.5.3. Envelope System

Generally used by individuals on a cash only basis, the envelope budgeting system essentially allows for bill payments with cash stored in different envelopes, grouped by expenditure category. This approach prescribes participation in the budget to enhance motivation, and that overspending in one category leads to curtailing expenditures in future envelopes, generating feelings of discomfort as you become increasingly aware that waste in one area translates into neglected, or unfunded, demands in others. What makes your envelope approach unique is your insistence on limiting consideration to variable categories considered important in your life, such as recreation, vacations, holidays, clothing, and so forth.

As a new budgeting systemer using envelopes only for discretionary items could be an acceptable beginning. You could gradually set aside smaller amounts for less enjoyable categories as you gain experience with this restrictive, rigid approach. Others using the envelope system allocate more fixed expenses than you would expect. They distribute their monthly rent or mortgage payments, utility bills, tax payments, insurance premiums, major upkeep budget, and other necessary expenses among appropriately labeled envelopes.

In summary, envelopes ordinarily represent discretionary expenses, but envelopes can contain amounts for fixed expenditures, major maintenance bills, and even savings that you want to resist touching. Perhaps envelopes could help those whose savings take place in a saving account, or those who set aside money in advance of shopping, tax payments, a planned vacation, or purchasing a car. The envelope system might also work well for others who experience difficulty building up savings, especially their emergency fund, and who want to consume less.

7.6. Technology in Personal Finance

Technology, particularly advancements in artificial intelligence, has totally revamped the field of personal finance – for better or worse. Millions of people have seen their financial lives improved through the rapid series of updates taking place in the world of apps and services. Bank accounts can be tracked, debts organized, spending optimized, and more through people's mobile devices. On the flip side, the rapid innovation in the field has also enabled large numbers of unsophisticated users to make a complete mess of their finances. People often blindly follow ad hoc advice given on personal finance blogs or social media by so-called "gurus" rather than following a personalized and science-based methodology. Mobile technology boosts the ease of tracking several innovative metrics, including net worth and budgeting over time – two pieces of financial data that are correlated with higher financial ability.

Banking apps have made it totally possible to track all accounts on a single platform, not just checking accounts as they did 20 years ago. Because of their large-user bases and available user data, banks and other institutions have access to deeper datasets than even leading fintech companies have. These datasets allow such institutions to provide banking services at extremely low costs, enabling the older institutions to provide cheap budgeting products designed to snag customers before they begin using tech solutions that charge monthly fees. As discussed throughout this chapter, budgeting is a methodical process and doing it daily is not necessary. Yet many people, particularly busy students, prefer something quick and dirty. Thanks to mobile reminders and geolocation technology, simple budgeting apps are relatively painless to use. People can budget while sitting in traffic or waiting in line at the grocery store.

Artificial intelligence and machine learning are without doubt one of the most exciting developments in the world of accounting and finance. Their disruptive influence is only going to grow. Among the predictions in the field is that all but the largest and most complex companies will stop hiring accountants altogether. Automated accounting and budgeting systems will be both extremely cheap to build due to rapidly dropping costs of the required machine learning and visual recognition technology, and also relatively cheap to operate, especially on smaller companies.

7.6.1. Mobile Applications for Finance

Users increasingly adopt mobile finance applications to shift savings behavior and other financial objectives, but reviews are scarce, and this area is ripe for study. Use continues to be strong and provides convenience through savings, earnings, and expense tracking, and budgeting tools. Security concerns exist and may mitigate likelihood and frequency of use. This class of applications may be able to address an economic agent's information asymmetries and cognitive shortcomings. Personal finance applications have the potential to address existing financial wellness gaps for different demographic segments. User-friendly budgeting and tracking tools have multicultural appeal and sway. Compliance and connecting to financial accounts is made easier. Tax time is in particular eased through the use of receipt scanning and organization capability. Security is mitigated and privacy concerns are addressed through using bank-level encrypted support.

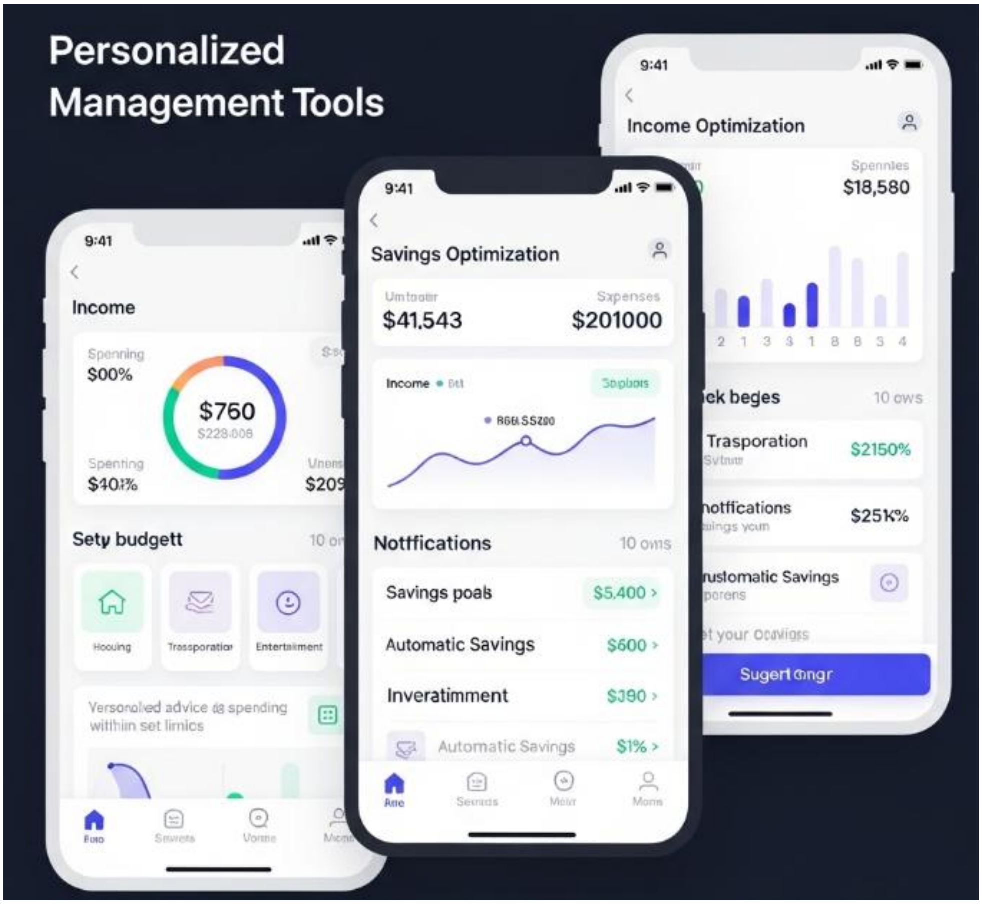

Fig 7.2: Personal Finance Management App Development

Digital technologies play a role in enhancing personal finances, but questions remain about which specific technology solutions are the most effective and address the greatest market need. A specific group of personal finance tools known as mobile applications aimed at personal finance problems are pervasive and numerous. These mobile applications undertake direct provision or the facilitation of the provision of specific components of personal finance. They have become more integral to users, with many tasks now designed to be accomplished using a mobile application. The economy is heavy on gig and freelance work especially exacerbated by COVID-19. Writing off expenses against taxes is commonplace. Unlike most expenses, tax time is special in that by using a mobile application specialized for tax time, users can access the benefits of a range of personal finance capabilities in a personal finance ecosystem that is all interconnected. The topic of technology in personal finance brings a host of exciting questions and problems that warrant further exploration.

7.6.2. AI and Machine Learning in Budgeting

Modern budgeting software offers features that are often not present in free services. For example, many paid budgeting tools allow for the sharing of one's budget with their spouse, partner, or family. This added feature that often justifies the subscription fee allows users to easily sync up with their spouses regarding financial projects, statuses, and accomplishes goals. Another paid service feature that often lessen the impact of the subscription fee is advanced reporting and analytics. Many modern budgeting applications, especially of the paid variety, offer users reporting capabilities, enabling them to dig deeper into their finances and get a clearer understanding of overall monthly spending habits, such as how much is typically spent each month on groceries, and where sensible constraints could be used to enable additional financial freedom.

Artificial intelligence and machine learning also have potentially profound applications in budgeting. For example, most budgeting applications today determine user income and monthly spending budgets according to either assumed averages or past data and consumer spending trends. AI could be applied to budget generation to create user budgets based on more recent spending information and contextual clues since real-time consumption is a much more important factor than consumer spending trends. However, other aspects of budgeting could incorporate machine learning as well. For example, categorization of expenses is common throughout budgeting software. This categorization is often susceptible to significant error. Many budgeting applications today rely on user overrides or user-generated categorizations of expenses to categorize future expenses coming from that line. Machine learning could be applied to budget-generated categorizations or budgets that use rules over the course of several months. In addition, AI could help implement more advanced spam classification for categorization of expenses if a natural language classifier-based solution was applied.

7.7. User-Centric Design for Finance Tools

User-centric design is a powerful tool, enabling researchers and practitioners to create useful and usable products. By emphasizing user needs and explicitly validating designs with users at every stage of development, user-centric design leads to solutions tailored to the target audience. The goal of user-centric design is to focus design and development by understanding and addressing the needs and priorities of relevant users. This is particularly important for tools that manage people's finances; research has shown that low income consumers have unique income streams, spending patterns, and barriers to saving. Failure to conduct this work can result in tools that are not used or that are not trusted. And, while the complex financial domains these tools address may lend themselves to expert-driven design choices, research suggests that experts rarely understand user needs as deeply as the users themselves. Indeed, experts may fall prey to bias due to their own experiences. As a result, the ideas generated by a user-centric process can be very different from those from an expert-driven process. When done effectively, user-centered design improves usability, eliminates risks of misinterpretation of market needs, and leads to fewer iterations, resulting in cost savings.

The requirements and priorities of people managing finances change over time; tools that assist in that management should consider notions of skill, tool, task, duration, equipped, and task structure. In addition, due to the strong emotional elements involved, research suggests that low-income users prefer affinity-based initiatives. User-centric design is not only about product design, in fact, many of the most well-known aspects of service design derive from user-centric design. For instance, designing intuitive interfaces that reduce the learning curve for vulnerable populations can enhance access to products and information for low-wealth individuals. Simple website navigation using recognizably named pages and clearly labeled questions, help buttons, and warnings can assist low-wealth individuals as they learn to use online financial tools.

7.7.1. Understanding User Needs

Developing finance tools like budgeting, savings optimization, and income management are pivotal in helping people reach their goals. Most existing finance tools focusing on budgeting or finding a good spending plan operate mostly behind the scenes tracking spending using data from bank accounts, while personal finance management tools feature budgeting solutions that allow users to synthesize information and reach their own goals. With such diverse features, the overlapping and distinct functions between personal finance management tools and budgeting tools may lead to confusion regarding the prototype's intended functions. Therefore, understanding users' needs and expectations are crucial for building the prototype intended to tackle data visualization issues due to the high complexity of personal finance for users.

The tasks of budgeting can be quite complex for users, especially when figuring out a suitable budget allocation for items within the same category. Because managing personal finance can become quite complex as time goes by, often leading to loss of interest, gamification methods perceive time as a valuable resource, particularly incentive systems. Dedicated to the use of incentive systems is a task-negotiation that can address how tasks are assigned in an effective way. Attribution Theory, when users feel under the cohort of an external influence to ignore and be subject to a loss of interest, is the basic premise of explaining the design of this game-mechanic-based incentive system. However gamification should not be over-emphasized, tasks involved in budgeting or any finance-related planning should be treated with caution in order to prevent over-dependence on those gamification effects. Balancing motivational and non-motivational factors is a challenge when creating gamified finance tools.

7.7.2. Creating Intuitive Interfaces

The interface of personalized finance tools is equally as, if not more, important than the algorithms behind the system. Users care more about how easy it is to use the tool rather than how sophisticated the technology is. Thus, usability is itself a critical element for user adoption of financial tools. It is important to guide users through the system while supporting high-level and flexible yet understandable decisions. Microfinance tools have been implemented in challenging environments where literacy levels are low, and understanding of some common financial concepts has to be carefully explained. For example, while designing an application for offering savings accounts in rural villages, the project team emphasized the importance of usability and conducted participatory design workshops. By that, they built low-tech prototypes that helped users identify design features and input formats allowing a better adoption of the application. Consequently, participants identified the need for an application that uses their native language as usability tools. Thus, programmers designed an application that allowed both a local language interface and voice feature combining.

Additionally, gamification can help incentivize desired behaviors, such as commitment through pledges. Although the option to opt out or be flexible in committed pledges is also necessary to avoid discouragement, it was found that incentivized savings models have limited success. However, if these tools target populations that are already technologically savvy, service design strategies advanced in service research could apply. Indeed, advancing available services can help influence user usage behavior via a new usage mindset by improving the adoption of services that would aid in managing dynamic, volatile intra-household and labor market mobility.

7.8. Data Security and Privacy

With the digitalization of almost all aspects of life and growing digital interconnectedness, what has become of utmost importance is the addressal of security and privacy issues. With relation to personalized finance tools, the view with respect to security and privacy is that more than offering protection, what may actually more help is creating a secure framework along with transparency regarding the entire security framework. Cybersecurity has progressed to making us aware of certain common things to safeguard ourselves from, such as phishing and linking to unknown and not trusted sites. But we are still in the early days of providing the kind of transparency and certainty to the end-user about what is being done with their data while implementing the actual techniques of machine learning and artificial intelligence which protects their data and keeps their privacy even in implementation.

Comparatively fewer attempts have been made to provide that transparency safekeeping of sensitive data such as personal finance data used in the development stage. Be it centralized servers or distributed servers, what has been of utmost importance is to ensure that these attempts, especially in the case of sensitive data but not limited to that, are not only able to provide user protection from bad attackers, but also give a geographical distribution-based safe and secure framework. That said, traditional confidentiality issues are an obvious given in the case of personal finance tools where a consolidation of personal finance data happens, especially with multi-party computations. Any consolidated pool of personal financial data may contain sensitive data about a user which should not be disclosed to completely unknown third parties for gaining insights. Certain norms already exist regarding companies disclosing insights based on collective information, but there are rules to ensure that no information about a specific individual is disclosed while reporting results.

7.8.1. Protecting User Data

The unprecedented public concern about identity theft and other forms of fraud creates a considerable hurdle for developers of financial products. Applications and platforms that deal with sensitive information associated with incomes, expenses, and assets must ensure that they protect their users from possible malicious intentions. The following discussion aims at highlighting what developers need to think about when it comes to the security topics of their applications.

The first and foremost design decision should be to use only the best service in class for the necessary part of a service. For sophisticated use cases renting technology seems like the best choice due to the amount of development and operating costs required to make it work in a secure way. Additionally, with these managed services, a firm does not need to invest significant resources to market the solution to their end customers. Lending and Fintech-as-a-Service Fraud Prevention solutions but also Cloud Dynamic ORB Services often provide fraud prevention technology that would be expensive or impossible to operate for a tech-averse startup but which is also widely trusted among users.

Security and privacy need to exceed those standard requirements of any other service in any other industry. This usually requires investing numerous human resources in the development of the product - something that is not a reasonable approach for smaller players who are yet starting. For that reason it is recommended to focus on only a small subset of specific risks during the early days when launching the product while taking the risk of losing customers coming from the target market who need a trusted partner who can provide a less risk-evasive product. Hence why later in the process it becomes necessary to consider investments into the means of an own SSO for the product to allow users to create accounts with similar or even the same data, linking them for a fast resolution of disputes.

7.8.2. Regulatory Compliance

To achieve the goal of providing personalized and optimal services to users, monetary policy and government regulations need to be considered. It must be noted that every country and region has their own financial policy and regulations, so there aren't universal regulations. However, in general, there are some basic regulations from governments and financial regulators that need to be complied with. First, the AML/CTF regulations will apply to any AI financial services that are initiating or facilitating financial institutions' financial activities and payment services. The payment service providers must comply with these regulations to help verify users' identities to ensure no illegal activities such as fraud and money laundering. Therefore, most underlying technology in the AI financial tool needs to block the entry of illicit funds to follow relevant regulations.

Second, products that impact taxation would be subject to tax related laws and regulations. Most AI finance tools, such as budgeting tools, price comparison tools, saving tools, etc., don't directly influence taxes. Taxation issues only happen when the income management directly involves tax liability. However, income related optimization in an AI finance tool that offers joint financial services through the connection with its partners can help identify and track items that are taxable events or are leading to taxable income. The AI finance tool needs to have knowledge to provide simple suggestions to reduce the taxable burden as a tool of communicating with users to reduce the risk of tax penalties. The considerations can help with the planning of queries in the income and expense domains. Such tax planning generally should consider different aspects of financial planning, such as changing residence, relocation, retirement, etc. Also, during the fiscal year, the AI finance tool needs to be regularly supervised to ensure its correctness by checking the transactional flow. It would be irresponsible to provide investment or personal finance advice with a lack of knowledge about tax obligations and history.

7.9. Case Studies of Successful Tools

Insights from successful personal finance tools can inform the development of novel tools that truly help users efficiently save, budget, and manage finances in ways that serve their individual preferences and goals. For example, some innovations include a branching decision tree that nudge users toward savings decisions that align with their future goals, integrating investment optimization alongside cash flow and budgeting considerations, and a focus on supporting cash payment decision-making and micro-budgeting. This leads to the following interesting questions: Which features enable such personalized finance tools to be successful and useful for users? Which design considerations or underlying implications result in the offering of a subset of successful tools? In order to answer these questions, we present case studies of 3 prominent personal finance tools that have considerable traction and established a large user base.

Mint is a free web-based budgeting application that allows users to view and manage all their finances in one place through linking external bank accounts and financial institutions. It categorizes and analyzes all transactions from the linked accounts, provides tips on how to save money and offers automatic suggestions for optimizing investment and bill payments, and alerts users when bills are due. Notably, Mint visualizes the user's financial health ticker at a glance with revenue sources, income vs. spending breakdowns, investments performance, credit score, debt tracking. These visualizations help the users better plan and budget by tracking their actual vs. budgeted savings for the month, keeping track of how much has been put away toward specific financial goals, and helping budget for upcoming bills by tracking unallocated funds.

You Need a Budget (YNAB) is a cloud personal budgeting software that is focused on helping users explore financial goals to become debt free, save more, and achieve their spending goals. Unlike traditional budgeting tools that mostly focus on visualizing or reporting previous spending activities, YNAB encourages users to dedicate every dollar to specific spending categories in line with monthly goals. It also provides insights to adhere to spending limits for each category to avoid overspending. YNAB uses a zero-sum budgeting approach by accounting for all transactions while also blocking "invisible" spending on credit cards. Unlike other automated and high-level tracking tools, users are encouraged to manually track spending across categories in YNAB so the cash flow for the month is essentially zero while focusing on debt clearance or savings.

7.9.1. Mint: A Comprehensive Budgeting Tool

Mint serves as a prime example of a successful personal finance tool. Initially developed as a Web tool to automate budgeting, it has since incorporated features to help users monitor their credit, savings, and investments. These additions have helped Mint increase the value it provides to users beyond personal budgeting and foster a user base of over 10 million and quickly growing. In contrast to most other budget tool options in the market, which require active user input in order to stay up-to-date, Mint is a data aggregator that pulls activity from linked external accounts. Mint is able to track user transactions in relation to user-defined budget categories and uses this information to populate relevant charts and visualizations, which are a strong point of the user interface. The Mint interface employs bright colors, both to prevent the interface from appearing too bland and to drive user emotions by displaying overly easy-to-achieve goals or categorizing certain finances in the red. Though the Mint platform has robust features, the application has been critiqued for its relatively poor search utility and suggestion accuracy. Prototyping upon these critiques would allow us to produce a comprehensive budget-management tool which would allow the small business owner to not only compare the health of their operations with relevant comparisons but also provide a solution to getting the unsavory information necessary to do so out of the box.

7.9.2. YNAB: Focus on Savings

YNAB, or "You Need a Budget" is one of the most popular platforms for budgeting assistance. It was founded by software developer Jesse Mecham in 2004 and has served to help people eliminate debt and take control of their savings. Central to its philosophy is the idea that every dollar needs a job, and that job should be to help the budgeting family on their journey to zero-based budgeting success. Zero-based budgeting, or being accountable for all of your expenses, creates a very detailed map of your family finances. This level of detail provides tremendous insights, especially in the area of discretionary spending. In fact, you essentially decide on your goal daily spending amounts, either for the next day or month, or even longer, so you know in real-time if you are in danger of going over budget. Using a budget helps eliminate that nagging stress of whether you will end the month in the red. You can also see if you have spending leakages or excesses in areas, such as food or entertainment, and adjust accordingly. Finally, YNAB's detailed record keeping can help families identify wants versus needs at all levels, allowing the most discretionary flexibility. The detailed tracking and discretionary controls allow users to move money from one virtual envelope to another, perhaps paying for family treats, or perhaps something special for Mom or Dad.

7.9.3. Personal Capital: Investment Management

Personal Capital is different from Mint and YNAB in that its initial focus was on investment management. It offers a suite of tools that provide its users with a macro view of their assets and how all of their investments contribute toward (or take away from) the long-term goals they have in life. The tools offered are free and allow users to do things like allocating their assets according to risk preference, reviewing their portfolio holdings and calculated fees, tallying the performance of all their investments, and creating an investment plan exercise. The services Personal Capital offers are light on details and mechanical in operation, not the full-fledged advisory-style services of other companies, although users can set up phone visits with financial advisors for a fee.

Users begin with a Welcome wizard before being ushered into a full-fledged investment dashboard. All of their portfolios are included in this view, sorted by long-term time horizon and calculated risk. Weightings are given for account balance, risk, and overall portfolio projected fees, while portfolio summaries with allocation across asset classes and holdings by percentage and value are easily accessible for each of the time horizon buckets. The investment tools are designed for users who want to consider the big picture of their total wealth, risk, and potential fees associated with their investment choices. With Personal Capital's visual approach and focus on net worth, it is a low-cost service for users who care about investing for retirement.

7.10. Challenges in Developing Finance Tools

Developing personalized finance tools capable of assisting users in income management, budgeting, and savings optimization can present serious challenges related to accessibility, credibility, and efficacy. We outline the most prominent challenges in this section.

User Engagement and Retention: Any digital financial management tool requires frequent user engagement in order to provide accurate and informative advice. A budgeting tool should continuously collect information on user expenses to be effective. However, a user might not wish to manually input this information. There now exist finance tools that automatically track ubiquitous expenses, but usually require the user to share sensitive bank information and permissions to query multiple bank and credit card APIs. This raises many questions about trust and safety, especially for users resistant to transacting online or who have had histories of identity theft or credit fraud. Even after security or incentive questions are addressed, such tools may still have lower rates of user engagement and retention during phases of income and expense monotony than needed for the recommended analysis. In these cases, output such as an alert or notification, delivered via email or text, may be ineffective in engaging users.

Adapting to Financial Changes: Because the financial situation of users is dynamic, rules developed using historical data to give advice on finances may not correctly reflect their value at the time advice is sought. For instance, consider a prediction model for income for an individual with a stable income over the last 3 years. If his current income is significantly less due to job loss or reduction in hours, the model may not be applicable, but its predictive capability may not become more relevant until a new period of stable income. The importance of this effect varies by user and for different financial states at different points during the life course.

7.10.1. User Engagement and Retention

With richer programming tools available, designers of financial management tools are encouraged to create solutions that are as elaborate as their imaginations can produce. However, a tool that is more extensive in its capabilities and more intricate in its design logically demands a greater level of user interaction than the simpler solutions. An especially promising solution that has become very popular in recent years are apps designed to automate personal financial management. Most of these apps attempt to provide weekly summaries of the user's account activity — to highlight upcoming bills, to identify any hostile takeovers of funds by subscription companies, to inform the user of their spending patterns across various line items, and to alert the user about potential budget breaches. These apps accumulate their richness of information upon connecting directly with the user's bank account and it is this very automatic nature of their operation that tempts us to sample these novel solutions. However, being invasive in our privacy does also create an invisible wall blocking the more unwilling among us from adapting to these tools.

The essential question that exists in the back of investors', advertisers', and developers' minds is the following: "Given financial dashboards' capabilities to provide extremely useful personalized management solutions, why is it that so few people actually use them?". Among the reasons lurking behind the meager engagement and retention numbers of existing personal finance management dashboards, there are some that are common to all computerized systems and some that are typical specifically for financial applications. Examples of the first group include being considered low-quality, slow response time, crashes, and data inconsistency; these are the reasons for most common disengagements across many computerized services.

7.10.2. Adapting to Financial Changes

Even though tool usage is systematic, the financial decisions of most individuals vary substantially over time. Since these decisions occur during inflection points in life events, micro aspects of the user’s profile change during a lengthy decision course, and the feature importance is dissimilar. For instance, housing purchase timing may be affected during the decision journey by constraints, uncertainty, and also risk merchant and broker selection, and these factors play diverging roles during distinct decision timesteps. This may produce conflicting predictive rules for distinct tool use spans. Thus, it is difficult to accurately derive decision prompts and provide relevant information at the right time using predictions, while simultaneously generating motivation to frequently use the tool, if the content is not personalized to the user's momentary profile. This highlights a challenge in addressing short-term personalized micro aspects when simultaneously maintaining long-term macro user needs.

Research and commercial tools invoke events to remind users to review or reset their plans or proposed actions when these changes occur: Financial tools propose updated tool content based on large changes in modeling parameters or user profile parameters. Modifying inputs can affect the predictions of both the main decision and alertness module, while also the offer and motivation-related modules. However, it is uncertain how such triggered changes in input affect user-triggered, unsupervised tool use. Additionally, many factors influence irreversible life events. Such influences can vary by location, macroeconomic indicators, or by their specific area of influence.

7.11. Future Trends in Personal Finance Technology

Developing Personalized Finance Tools for Income Management, Savings Optimization, and Budgeting As various respondents stated, increasing volatility of both the economy and users' contexts gives ground for serious changes in the industry of personal finance management tools. As with most techno-economic systems, such changes are primarily caused by technological development. For our field of investigation, we see two major technological evolutions provoking potential disruptions: integration of Blockchain technology on one side, and the rise of Robo-Advisors on another.

The Blockchain technology enables to implement smart contracts and more generally the so-called "trust-free" models of relationships between individuals and companies. "Trust-free" means that, thanks to Blockchain's model of several copies of the same database accessible for all users, no longer any certificate or control institution is required to check if a property transaction is correctly executed, or if a money remittance is done. As a consequence, intermediary institutions like banks, or more generally trust-3rd parties, have less and less utility, thus slowly but surely losing their control over the market. This is likely to provoke a major transformation in the finance industry, leading to the emergence of pure peer-to-peer models. In such a context, banks will not "disappear", but rather change their business models, and provide new types of services.

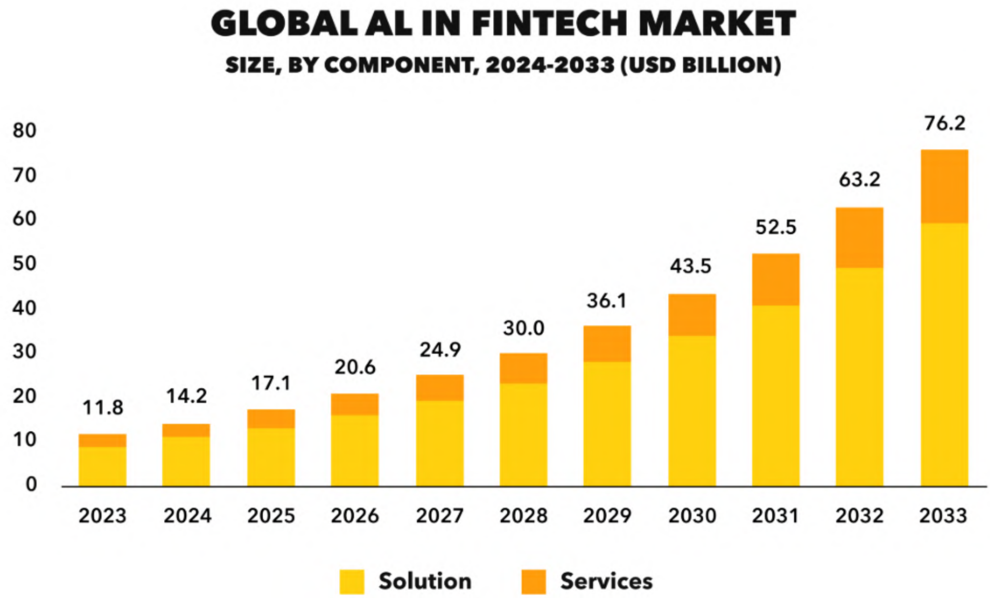

Fig : Shaping the Future of Finance

We have seen earlier that wealth management services are difficult and costly to deliver. Traditionally, banks and financial providers have arbitrarily imposed a minimum threshold under which potential clients are rejected. Roboadvisors are starting to provide tools for wealth management services without any minimum threshold, thus democratizing private equity investment. The boom of social networks and crowdfunding systems, along with the rise of fintech purely focused on low-income clients are likely to accelerate this disruption process. The slow but sure emergence of the bank as a service model, enabling white label applications to leverage on the core banking infrastructure of incumbent providers can speedup this evolution. As seen earlier, such a model is likely to commingle rich valuations and low commissions.

7.11.1. Integration of Blockchain

With a background in cryptographic technologies and extensive experience at both the National Security Agency and a private company, Jon Matonis summarizes the blockchain as follows: "A blockchain solves the double-spending problem using a peer-to-peer network – an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way. The reason this record can succeed is that it eliminates the need for a trusted third party in the transaction process." His technology can potentially serve preparations for account settlement in all areas of information exchange. Among the first applications of blockchain technology, we find Bitcoin, a decentralized virtual currency based on a blockchain and designed to allow payments among anonymous users. Who sees Bitcoin as the digital currency of the future? "'What we have built is a currency that is better than what we have today,' said Bitcoin co-founder and former chief scientist." Ledgers and smart contracts, two of the most promising blockchain applications, are of particular importance for personal finance technology.

With ledgers, the reconciliation and settlement process is shared among an authorized group working on a common data source. Just like anything else, finance is subject to data errors, missteps, inconsistencies and misunderstandings. Ledgers and specifically distributed ledgers allow data owners to record amendments, along with the changes' provenance, to a record in an immutable and secure way so those changes can be approved as valid by authorized parties on a shared basis.

7.11.2. The Rise of Robo-Advisors

In recent years, there has been a rapid rise in the popularity of robo-advisors, automated systems providing investment advice and asset allocation. These seem to be replacing financial advisors for a considerable number of investors, as average fees are significantly lower, usually around 0.25% of assets managed. The systems suggest basic portfolios of stock and bond exchange traded funds, and rebalance periodically. While these services can fill a needed gap, they may not take into account the whole financial picture for many people. For example, they cannot take into account the needs for specific funds at specific times, such as college tuitions, and may thus not provide suitable strategies for people who need to sell equities in the near future. However, for long-term investors, with suitable risk tolerance, such funds are likely to outperform far more complex alternatives. Several banks have also begun to offer such services.

The original idea for the construction of portfolio asset allocations was the Modern Portfolio Theory, proposed by Harry Markowitz. The crux of MPT is that by combining many different uncorrelated or negatively correlated assets, there are efficiencies to be gained in reducing risks, without necessarily sacrificing returns. Thus, for example, combining stock in various sectors should yield less risk than investing in any one. Adding bonds to the mix, which do not have the same risks as equities, should increase the risk-reduction at the same time. However, investors are not all alike. Individuals have different risk preferences, depending on their income, net worth, financial needs in the near future, and personality. How one feels about the risks impacts on any investment taken. For example, for a family who has most of their wealth tied up in a house, with little saved for retirement, and with children in college, the 25% of portfolio losses during the Great Recession would have likely resulted in the need to sell at the worst possible time and lose a substantial amount of money.

7.12. Conclusion

The two principal foundations of financial and economic development for modern economies are firstly the smooth running of the Finance System and, secondly, the creation, diffusion, and employment of Knowledge-Intensive Innovation — where Knowledge refers to the modelling and simulation of reality. In this context, I propose to show in this text that a synthesis of Finance Tools with Financial Knowledge and Forecasting could provide a basis for creating a radically new range of Personalized Finance Tools with Increased Financial Awareness, Capability and Knowledge for Individuals, Households and other dimensions of Societal Sustainment. Very little time is in fact spent in Financial Planning and Management of the Family Finances when compared to the sum of Time spent Such Functions and the many Costs involved in Failure during the Lifetime of the Individual and Society Within Which Division of Labour occurs, External Effects and Market Failures are increasingly present, Information Asymmetries exist and Creative Destruction, Global Climate Change and Socio-Cultural Issues with Societal and Community Are increasingly important during Societal Planning and External Strategic Management. The growth of Internet Usage and, more recently the emergence of social networks have begun to improve on-line Sophistication, Usage and Innovation in Resources on the Internet World Wide Web. Financial Advisers and The Services of Increasing Numbers Recent years have also seen increasing concerns and a number of Delivery Websites devoted to specific sectors of the Finance System with Desires to Assist Private Sector Banks and Financial Partners in Creating and Delivering Cost-Effective Financial Policy Tools and Programs for Net Betterment of Residents on Non-Domiciled Resident Private Finance Book Balance Sheet Effects.

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