# Michigan Transportation Construction Price Index

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**REPORT ON STRATEGIC USES OF MICHIGAN HIGHWAY
CONSTRUCTION COST INDEX**

**October 21, 2020**

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**16. Abstract**

The Highway Construction Cost Index (HCCI) measures the price changes of construction items over time in the highway construction industry. It is designed to monitor fluctuations in highway construction market conditions and to indicate the purchasing power of the infrastructure agency. Although many state DOTs, including Michigan DOT (MDOT), have developed various HCCIs, best practices regarding the use of HCCIs by DOTs have not been thoroughly investigated. As revealed by a nationwide survey on HCCI uses conducted in this study, the use of HCCIs has typically been limited to, for example, budgeting and estimating. Still, there is a lack of a systematic approach to applying HCCI in the DOT practices. As such, the research presented in this report aims to develop a strategic plan for applying HCCI in MDOT practice. The research objectives are pursued through the dual approach of (1) a literature review, and (2) nationwide and statewide surveys. Leveraging the survey results, academic literature, and industrial reports regarding HCCI use, we synthesize a strategic plan for MHCCI application consisting of prioritized uses and a technical implementation guide. This plan provides MDOT with guidance concerning the use of HCCI for various purposes, including, but not limited to, (1) projecting future funding needs, and (2) developing more accurate construction cost estimates, and (3) monitoring, benchmarking, and reporting construction market.

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# Acknowledgements

# TABLE OF CONTENTS

## List of Figures

**List of Tables**

**EXECUTIVE SUMMARY**

The Highway Construction Cost Index (HCCI) is an indicator of fluctuations in highway construction market conditions. A number of states (such as Iowa, Ohio, etc.) have developed their own state-level HCCI in order to better manage the funding of an augmented program. In the absence of a state-level HCCI in Michigan, Senate Bill no. 515 was introduced in 2019, requiring MDOT to establish a state-level cost index by May 1, 2020, and to subsequently provide quarterly updates to the house and senate transportation appropriations sub-committee. In this context, the overall goal of this research project was to (1) develop the Michigan state HCCI and historical trend index for Michigan, as well as (2) identify best practices for the implementation of the HCCI, such as future budget needs, cost estimating techniques, and project scoping. The present report (i.e., *Final Report II*) describes the best practices identified regarding deployment of the HCCI by the MDOT. (The development of the MHCCIs and the historical trend value are documented in *Michigan Transportation Construction Price Index Final Report I*.)

To accomplish the research objectives regarding the application of HCCI, the research team undertook a comprehensive literature review to uncover similar studies on HCCI use. The team then conducted a nationwide survey of state DOTs to elicit information on current practice regarding the use of HCCI. As revealed by the nationwide survey, the primary uses of HCCI include (1) budgeting for upcoming fiscal years, (2) cost estimation, either scoping estimation or engineering estimation, and (3) monitoring and benchmarking within the construction market. The team then conducted another survey within MDOT to gather opinions on and prioritize the identified uses for MDOT. Based on the survey results, budgeting for upcoming fiscal years and cost estimation analyses were given the highest priority as HCCI applications. Lastly, the research team developed recommendations for strategic uses HCCI, such as for MDOT's future budgeting needs, cost estimating techniques, and project scoping.

# 1. INTRODUCTION

A Highway Construction Cost Index (HCCI) measures the price changes of construction items over time in the highway construction industry. It is designed to monitor fluctuations in highway construction market conditions, as well as to gauge the purchasing power of the infrastructure agency. As such, the Federal Highway Administration (FHWA) and several states (such as Iowa and Ohio to name a few) have developed federal- and state-level HCCIs in order to better plan, budget, and manage their budgetary spending on construction projects.

Recently, a state-level HCCI for Michigan has been established as mandated by Senate Bill no. 515. As part of this initiative, an MHCCI calculation tool has been developed to automatically clean, edit, and select bid items, as well as calculate quarterly and annual MHCCI at various aggregation levels, such as overall state, item category, and sub-regions. The methods underlying the development of the MHCCI and its historical trend value, it should be noted, are described in *Michigan Transportation Construction Price Index Final Report I* (Liu et al., 2020).

## 1.1 MHCCI Tool

Development of the MHCCI tool entailed the development of an automated HCCI calculation system as a standalone application using the Python programming language. The system architecture of the automated HCCI calculation system is presented in Figure 1. Generally, it includes (1) an Excel database where all historical data of pay items are stored; (2) an HCCI calculation engine designed to automatically clean data, sample pay items, and calculate HCCI value; and (3) graphical user interfaces (GUIs) that allow users to interact with the system and that also display the HCCI results.

The Excel database contains the data attributes required to calculate the HCCI and sub-HCCIs. Typical attributes include item quantity, bid price, unit, item description, pay item codebook specification year, and so forth. Several algorithms are included in the HCCI calculation engine to clean, sample, and edit pay items, as well as perform the HCCI calculation. For instance, natural language processing (NLP) algorithms are encoded to tokenize item descriptions and link pay items across different catalogs. In contrast, statistical algorithms are included to perform analysis for data outlier cleaning, data sampling, and editing. Figure 2 presents the GUIs of the prototyped system. As shown in Figure 2, the developed tool allows the user to select the HCCI

2

aggregation level, such as overall state HCCI, sub-HCCI by region, or sub-HCCI by category. All the system components are integrated using the Python programming language. The user guide for the developed MHCCI tool is presented in Appendix C.
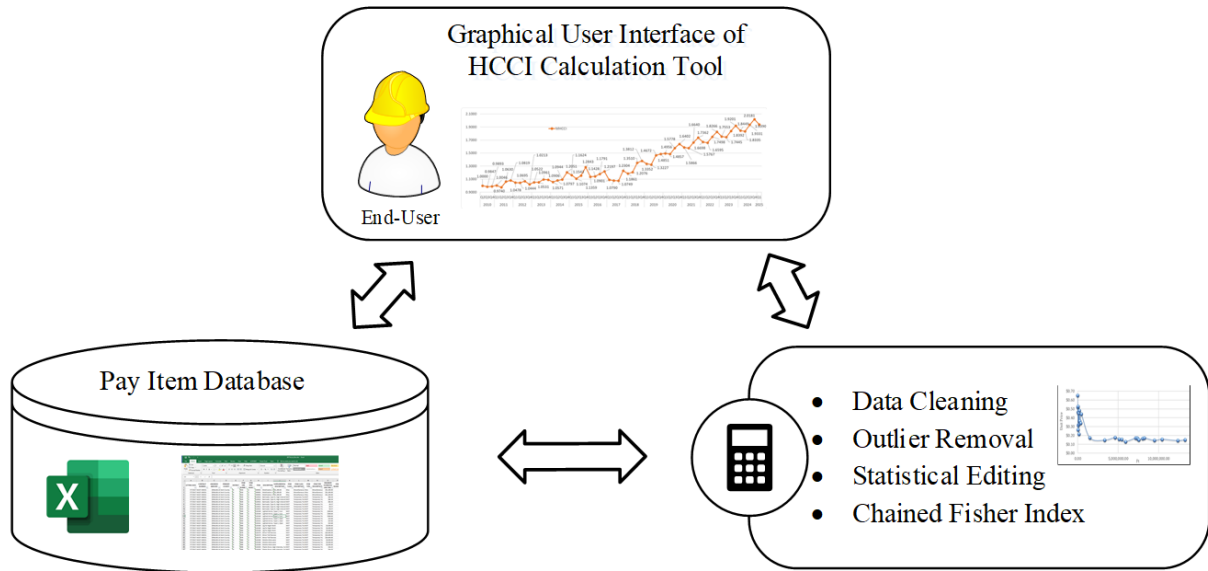


Figure 1. System architecture of the prototyped MHCCI tool
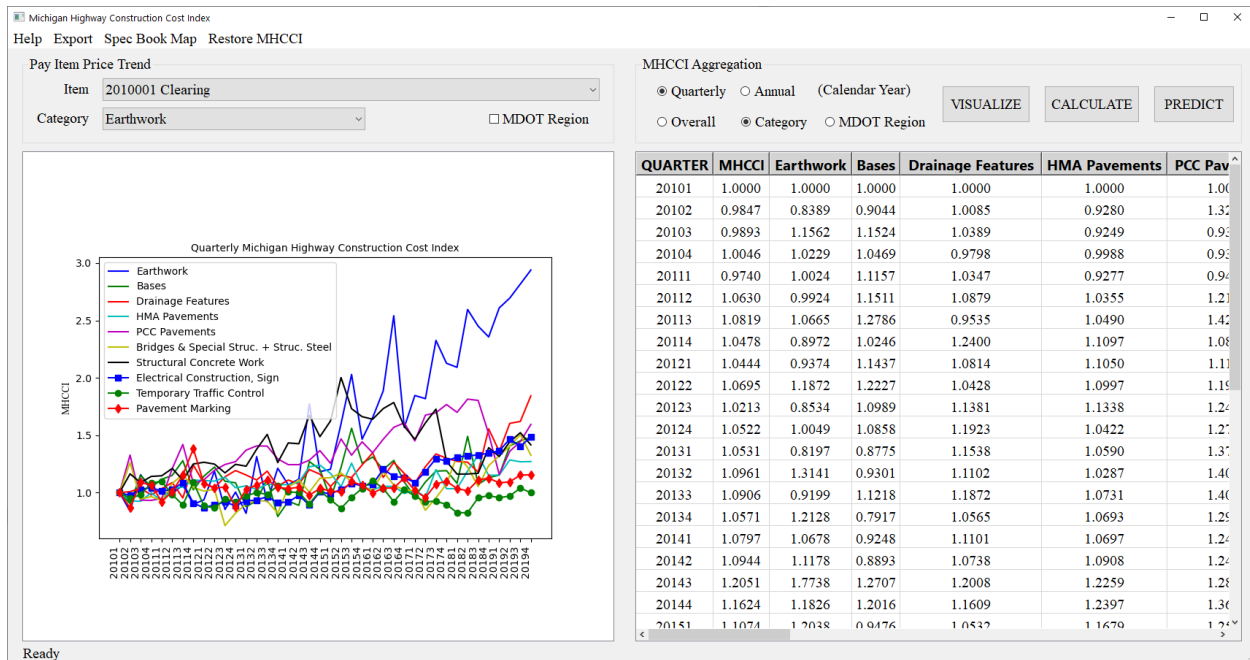


Figure 2. GUIs of the prototyped MHCCI tool

3

The tool provides a broad coverage of bid items in the HCCI calculation and ensures the reliability of the calculated HCCI as an indicator of changing market conditions. It is also capable of forecasting statewide quarterly and annual MHCCIs for the next five years. Leveraging this tool, MDOT can provide quarterly updates on the MHCCI values, as well as MHCCI predictions.

Although many state DOTs, including MDOT, have developed HCCIs, the effective application of HCCIs in practice has not been thoroughly investigated. As revealed by a nationwide survey on HCCI use administered as part of this study, the use of HCCIs has in most states' practice typically been limited to simple budgeting and estimating tasks. What has been lacking is a systematic approach to HCCI use.

## 1.2 Objectives

The research presented in this report aims to develop a strategic plan for applying HCCI in MDOT practice. Such a plan can provide valuable guidance to the MDOT regarding the use of HCCI for various purposes, including, but not limited to, (1) projecting future funding needs, (2) developing more accurate construction cost estimates, and (3) identifying the root causes of trends in cost estimation. In specific, the objectives of the research presented in this report include:

1) Identification of best practices on the use of HCCI for the MDOT's future budget needs, cost estimating techniques, and project scoping.
2) Development of a strategic plan for HCCI application in MDOT practice.

## 1.3 Summary of Tasks

The research objectives were pursued in two steps. First, a literature review on the use of HCCI was conducted with a focus on comprehension and synthesis. The identified uses of HCCI were summarized and used to design nationwide and statewide questionnaires. The second step was to administer the developed questionnaire to industrial practitioners. A survey on other states' current use of HCCI was distributed to DOT representatives, including state-level DOT representatives and FHWA representatives. After that, a second survey was administered to MDOT representatives for the purpose of soliciting expert input to inform the prioritization of potential

uses of HCCI and opportunities for improvements concerning the adoption of MHCCI. On this basis, a strategic plan for applying HCCI in MDOT practice was formalized as discussed later in this report.

**1.4 Organization of the Report**

A full description of all work performed as a part of this research is provided in the chapters that follow. Chapter 2 reports on the survey of other state DOTs' uses of HCCIs. The survey sought to ascertain other state DOTs' primary uses of cost indices. This survey garnered 31 valid responses, a 63% response rate.

Chapter 3 reports on the survey of MDOT representatives regarding potential HCCI uses and priority areas. This internal survey received nine valid responses, most of them from regional development officials such as regional system managers and regional project managers.

Chapter 4 discusses the prioritized uses of MHCCIs and outlines guidelines for the use of MHCCIs for each prioritized purpose. It also outlines best practices and recommendations for the effective use of MHCCIs. The conclusion of the report is then presented in Chapter 5.

The questionnaires used for the nationwide and statewide surveys can be found in Appendix A and Appendix B, while Appendix C is the user manual for the developed MHCCI tool.

## 2. SURVEY OF OTHER STATES' HCCI USES

### 2.1 Introduction

A survey was conducted to identify other states' current practices and applications of HCCI, and to gain in-depth understanding of best practices in terms of the use of HCCI. The questionnaire was developed based on an extensive review of the literature regarding the use of HCCI and cost management (see Appendix A).

### 2.2 Survey design and administration

The research team developed the questionnaire in such a manner as to solicit responses well aligned with the objectives of the survey. The following five steps were followed by the research team in the development and administering of the survey:

1. Develop a draft questionnaire that takes into consideration the HCCI uses identified in the literature review.
2. Obtain feedback from the Research Advisory Panel (RAP).
3. Conduct pilot survey.
4. Finalize the questionnaire based on the findings of the pilot.
5. Distribute the survey to DOT representatives via the email list of the AASHTO Committee on Construction and Committee on Design.

The survey was distributed to state DOT representatives and an FHWA representative on July 7, 2020, via email, and we continued to accept responses until July 24, 2020. One reminder was sent out as a way of increasing the number of participants. In total 32 participants completed the survey, a response rate of 63%.

### 2.3 Analysis of survey data

This section discusses the results of the questionnaire survey.

**2.3.1 Participating state DOTs**

As mentioned, 32 responses were received, including 31 state DOT representatives and one FHWA representative. The responding states are shown in the form of a map in Figure 3. As can be seen, the DOT representatives of three of Michigan's four neighboring states (the exception being Illinois) participated in the survey.
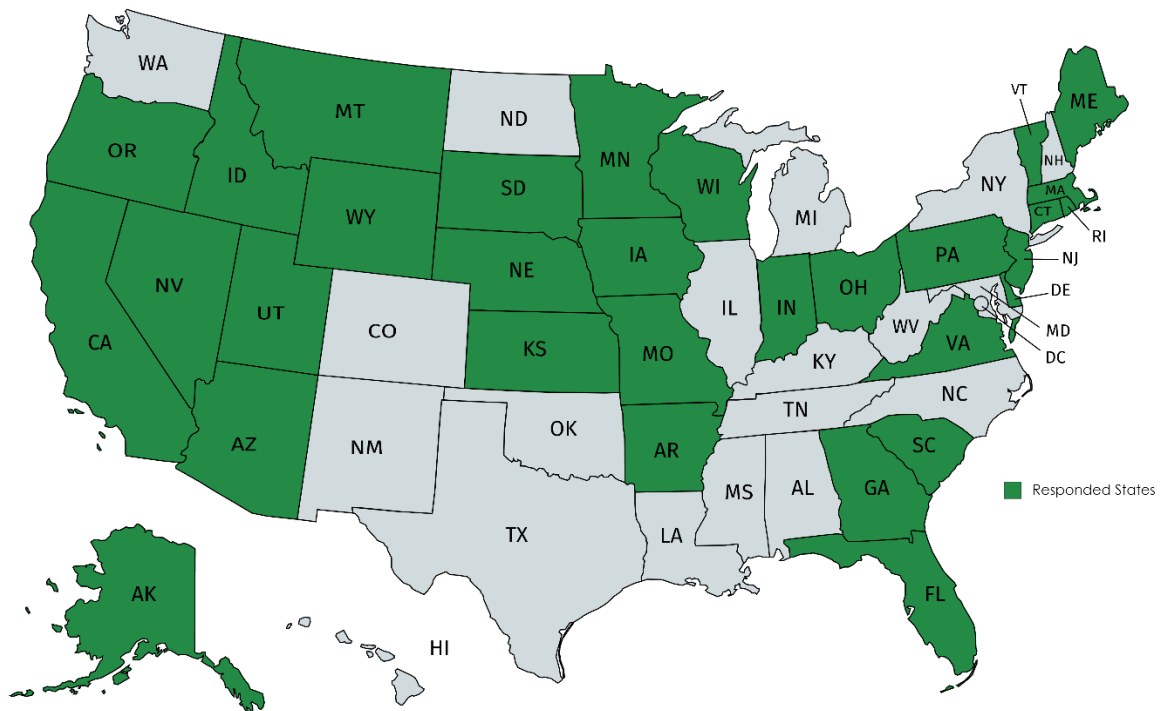
Figure 3. Responding states

**2.3.2 Number of state DOTs using HCCI**

Among the 32 participants, 23 indicated that their respective agencies use HCCIs in cost management. In contrast, the remaining nine participants reported that their agencies do not use any construction cost index for cost management. These nine are Alaska DOT&PF, Connecticut DOT, MaineDOT, Missouri DOT, Nevada DOT, South Carolina DOT, Vermont Agency of Transportation, Virginia DOT, and Delaware DOT.
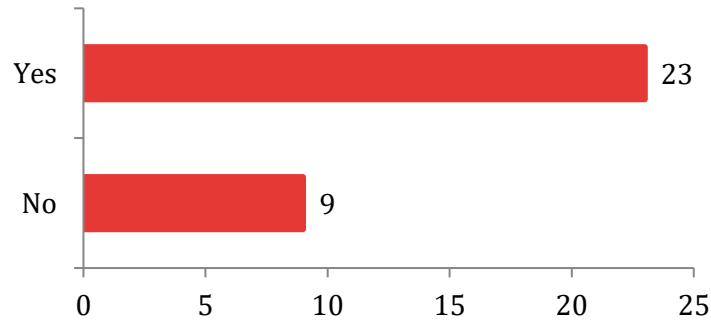
Figure 4. State DOTs using HCCI (Y/N)

To take into account cost inflation, these nine state DOTs general reported using an estimated inflation rate in the range of 3-5% in their cost estimation. Table 1 outlines the various approaches to factoring cost inflation in cost estimation without HCCIs as reported in the survey.

Table 1. Taking into account inflation without the use of HCCIs

| |
|---|
| *"Most estimating and budgeting is done in current dollar values. on large ticket items we will look at current trends and make adjustments if needed on a project by project basis."* |
| *"We do not have a standard process for considering inflation. It is typically up to our estimators to determine an inflation percentage."* |
| *"We estimate project costs by utilizing historic costs, geographical location and amount of quantities. We perform an independent cost check with internal staff."* |
| *"Yes a 3% factor is applied to the outer years of the Statewide Transportation Improvement Plan (STIP)."* |
| *"Either through AASHTOWare Estimator or by direct calculation (inflation rate/year times number of years, simple not compounded)."* |
| *"About the most scientific cost inflation is done in our construction phase where we add 3% to the bid as we have found that is the common escalation of prices from beginning to end. Common practice for estimating is around 5% per year but most of our work is estimated in the year before it is going out."* |
| *"We currently utilize the annual inflation provided by FHWA, but are well underway to develop a CCI."* |
| *"It really doesn't."* |
| *"We use escalation clauses in our contracts for liquid asphalt."* |

## 2.3.3 Number of state DOTs that calculate HCCI

Among the 23 participants who did report using HCCIs, 19 reported that their agencies calculate their own HCCIs. The other four—FDOT, MassDOT, Oregon DOT, and Kansas DOT—reported that they do not compute their own HCCI values, instead using other states' HCCIs or third-party cost indices.
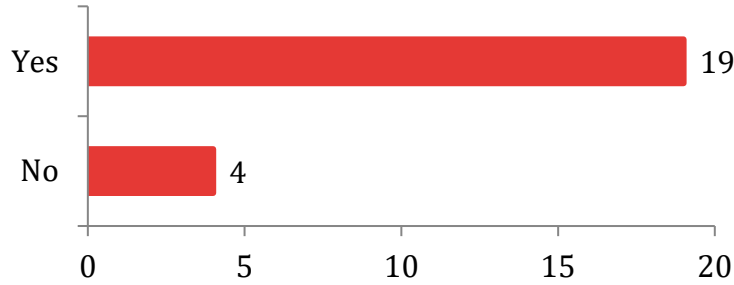
Figure 5. State DOTs that calculate HCCI (Y/N)

### 2.3.4 Frequency of HCCI calculation

Among the 19 participants who reported calculating their own HCCIs, 11 state DOTs and the FHWA reported calculating their HCCIs on a quarterly basis. In contrast, Rhode Island DOT, Georgia DOT, and NJ DOT reported using a monthly interval for HCCI calculation, while Wyoming DOT, South Dakota DOT, and Montana DOT reported calculating their HCCIs on an annual basis. Finally, ADOT reported estimating HCCIs semi-annually, WisDOT reported both quarterly and annual HCCIs, and Nebraska DOT reported computing quarterly, annual, and semi-annual HCCIs.
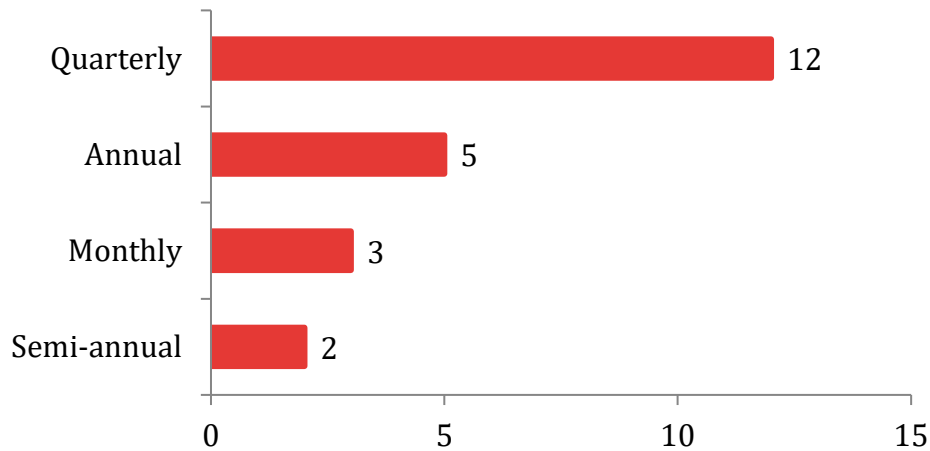


Figure 6. HCCI frequency

9

**2.3.5 Aggregation level of HCCI calculation**

HCCIs can be calculated at three aggregation levels: (1) overall state, (2) categorical, and (3) regional. In addition, some state DOTs calculate the material price index (i.e., material HCCI) for material escalation clauses during construction. This question sought to gather insight on what HCCIs are commonly calculated by state DOTs. The responses (Figure 7) are summarized as follows:

- The majority of state DOTs reported that they calculate categorical HCCI (i.e., pavement, earthwork, etc.). These agencies include Arizona DOT, AR DOT, Georgia DOT, Indiana DOT, Iowa DOT, Minnesota DOT, Montana DOT, Nebraska DOT, Ohio DOT, SD DOT, Utah DOT, and Wyoming DOT.

- Ten agencies reported that they calculate overall state or jurisdiction HCCI: California DOT, FHWA, Indiana DOT, Minnesota DOT, Montana DOT, Ohio DOT, Rhode Island DOT, SD DOT, Utah DOT, and WisDOT.

- Ten agencies reported that they calculate 'material' HCCI, e.g., concrete, hot-mix asphalt (HMA), and steel: ARDOT, California DOT, FHWA, Idaho DOT, Minnesota DOT, Montana DOT, Pennsylvania DOT, SD DOT, Utah DOT, and WisDOT. However, none of material HCCIs from these states can be founded. The reason might lie in that the respondents were confused about the difference between categorical and material HCCIs. For example, reinforcing steel HCCI is a categorical index, rather than a material index. On the other hand, some material price indices are not aggregated based on pay items, and are instead calculated for material escalation clauses during construction based on current price and base price.

- Only three state DOTs—Montana DOT, NJDOT, and Utah DOT—reported computing the HCCIs for their subregions.
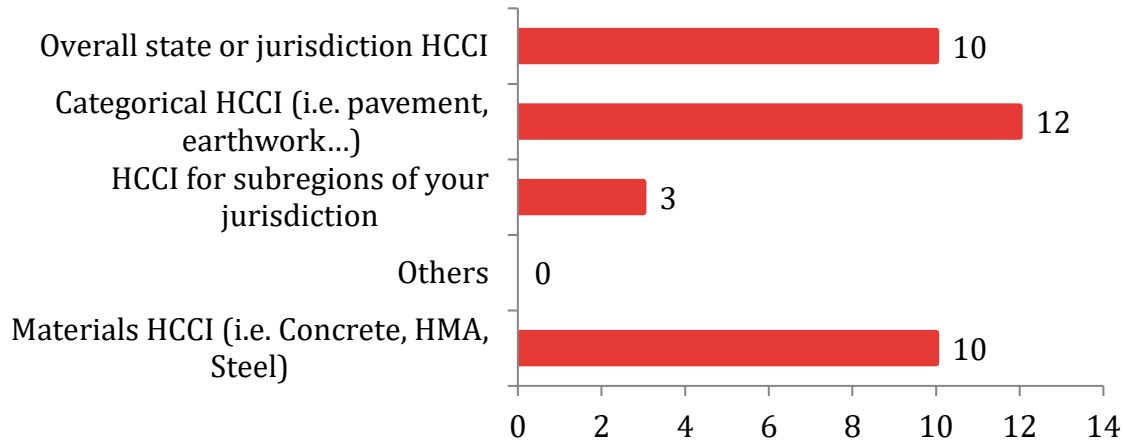
Figure 7. HCCI aggregation level

## 2.3.6 State DOTs using other HCCIs

Figure 8 presents use of other states' or third-party indices. Eight agencies reported using other states' HCCIs or third-party cost indices (including four states that also calculate their own HCCIs, and four that rely exclusively on other states' or third-party HCCIs). These include FDOT, Idaho DOT, Indiana DOT, MassDOT, Minnesota DOT, Montana DOT, Pennsylvania DOT, and Utah DOT. The other fifteen agencies reported that they do not use any other cost indices and are confident to use their own HCCIs for cost management.
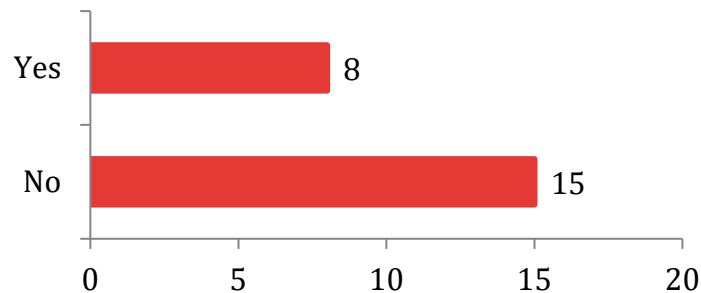


Figure 8. Use of other states' or third-party indices (Y/N)

### 2.3.7 Other HCCIs used by state DOTs

Among the third-party indices, NHCCI is the most widely used cost index as reported in the survey (Figure 7), being employed by four agencies (Minnesota DOT, Montana DOT, FDOT, and Idaho DOT). Global Insight, Engineering News-Record (ENR) CCI, and BLS PPI are in second place, each in use by three of the participating state DOTs, such as Indiana DOT, Minnesota DOT, Montana DOT, Idaho DOT, Pennsylvania DOT, and FDOT. In contrast, the RSMeans City Cost Index and P.B.'s HCCI are used by Pennsylvania DOT and Montana DOT, respectively.
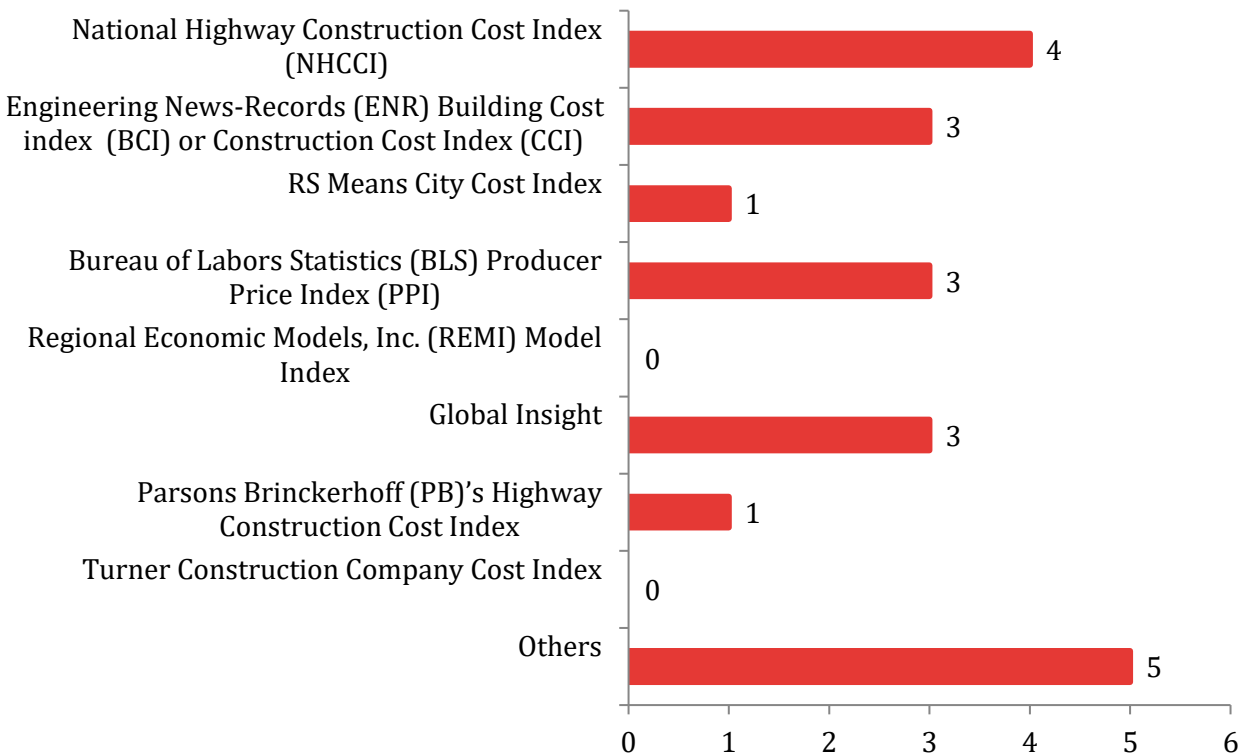


Figure 9. Other indices used by DOTs

In addition, some state DOTs also monitor and use HCCIs from their neighboring states; for example, MnDOT uses Iowa DOT's Price Trend Index. Other indices used by state DOTs include the Poten & Partners Asphalt Index and the Argus Asphalt Report for asphalt binder prices.

12

## 2.3.8 Uses of other HCCIs by state DOTs

According to the survey findings (see Figure 10), state DOTs primarily use other cost indices for comparison purposes. They compare their in-house HCCI with these cost indices, such as NHCCI 2.0. One respondent (the Massachusetts DOT representative) reported that their agency relies on third-party HCCIs to determine the inflation rate for their construction projects because they do not calculate their own HCCIs. Utah DOT reported other uses of third-party HCCIs, such as for calculating price escalation. They also use other indices, along with their in-house HCCIs, for cost management.
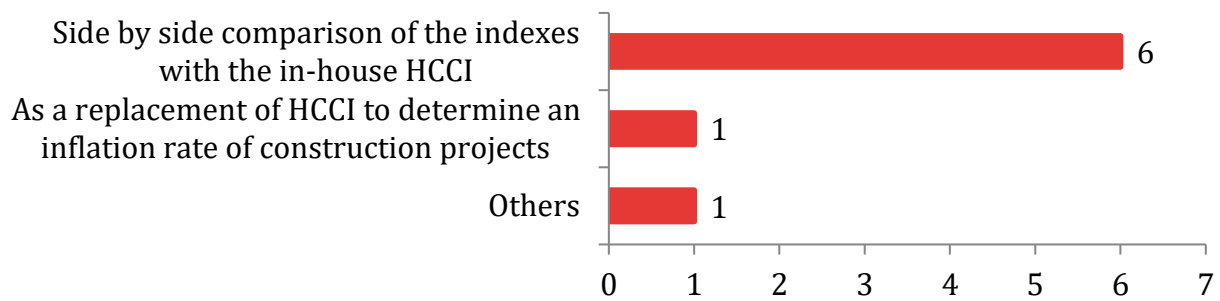


Figure 10 Usages of other indices

### 2.3.9 Users of HCCIs in state DOTs

Participants also reported that various offices within their respective state DOTs have multiple uses of HCCIs. As shown in Figure 9, planning offices are the primary users of HCCIs. The reason may lie in that HCCIs are mainly used to budget construction projects for future fiscal years. Design and development offices also use HCCIs relatively frequently, followed by Construction and Finance/Contracts. This is because HCCIs are also widely used for engineer's estimate, for calculating cost inflation factors for future contracts, and in developing price adjustment clauses. In addition to state DOTs, other users of HCCI include MN Concrete Pavers Association.
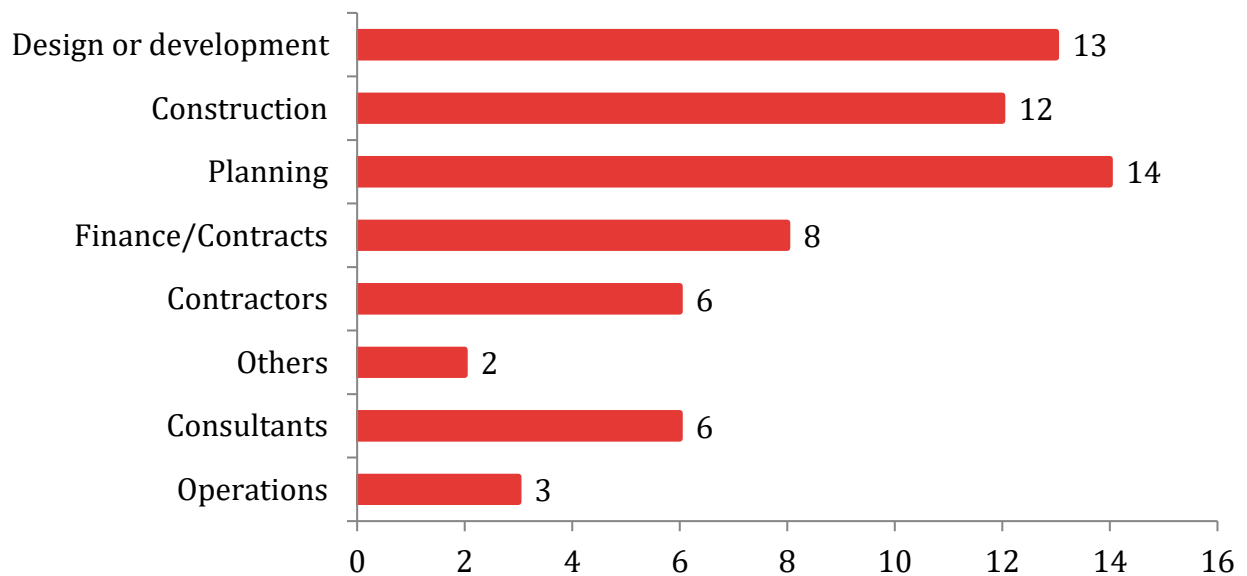


Figure 11. Users of HCCIs

### 2.3.9 Uses of HCCIs by state DOTs

The primary uses of HCCIs in DOTs as reported in the survey are presented in Figure 10. As shown in the figure, budgeting for future fiscal years (14 state DOTs), preliminary cost estimation (12 state DOTs), engineer's estimate (9 state DOTs), checking of historical trends (9 state DOTs), and monitoring of construction market fluctuations (9 state DOTs) are the most common uses of HCCIs.
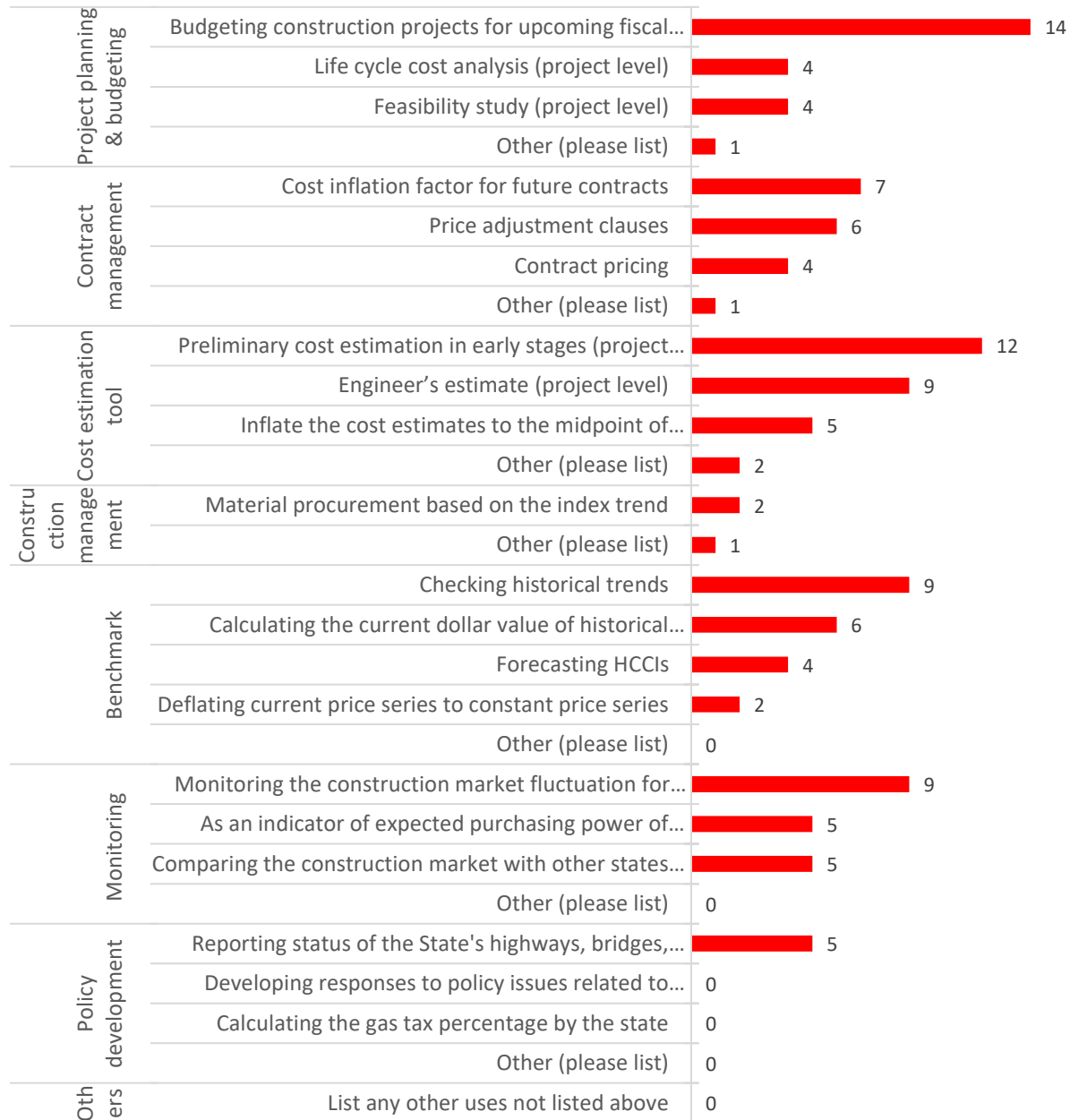


Figure 12. Main uses of HCCIs

15

In terms of contract and construction management, HCCI is also used to inflate bid prices to current dollars for either change order price negotiations or price adjustments during construction.

## 2.3.10 Descriptive Uses of HCCIs by state DOTs

Several participants also provided detailed descriptions of HCCI uses. Table 2 summarizes various applications of HCCIs for construction projects. As noted in the table, HCCIs are widely used to monitor the market conditions by looking at the historical index trends and forecast inflation factor for cost estimation.

Table 2. Description of uses of HCCI

| |
|---|
| *"Engineer's estimates are adjusted based on bi-annual HCCI."* |
| *"Primarily for forecasting trends and conditions, and reporting CCIs to Executive Management. Also as a monitoring tool for Construction (Materials Office) to foresee possible areas of material shortages and the resulting production and financial impacts to the work program."* |
| *"We mostly develop our HCCI to compare to the national CCI's. We use them to develop our inflation rates for the next 5 years"* |
| *"The HCCI:*<br>*- is used to inflate current project cost estimates to the date of projected contract letting,*<br>*- is used to adjust future year cost estimates for the mid- and long range capital program, - is used to inflate operating and maintenance budget costs in the long range financial plan - provides commodity specific price forecasting information to planners and project designers, - provides a second opinion for fuel hedging program"* |
| *"The HCCI is used to prepare the inflation forecast each year. The inflation rates are then used to inflate project construction costs to the year of construction for program management, to compute lifecycle costs for pavement type selection and to adjust historical bid prices to the current year for use in cost estimating, and to adjust historical bid prices for various studies.*<br>*Many areas across MnDOT use HCCI historical values and forecasts. For instance, my Office of Transportation System Management primarily interacts with project estimators, planners, and financial analysts. It may be most helpful for you to have targeted conversations with individuals about specific uses you're interested in understanding better. "* |
| *"We monitor the indices to keep track of market conditions. We look for trends (prices going up or down or staying consistent)."* |
| *"The In-house HCCI is used mainly as an assessment tool to understand how construction pricing trends will affect programmed budgets. Other indices are used primarily for material escalation clauses during construction."* |
| *"Planning uses our CCI to develop a forecast model for future trends. The forecast is used in budgeting future projects. Design uses our CCI to adjust past prices into current dollars. Central office uses our CCI to monitor recent price fluctuations for item classes such as asphalt pavement, structures, concrete pavement, earthwork and more."* |

| |
|---|
| *"It is a budgetary tool used in the STIP and in the Planning office"* |
| *"The CCI is not widely used. The ones who do use it, use it to get a very preliminary cost estimate for a project. "* |
| *"1) Cost trends are shown during legislative budget process. 2) HCCI is used by statute to adjust the dollar value of work allowed by OhDOT's own forces. 3) Cost sharing calculations with private developers. 4) To create a current cost set of data for calculating bid history prices for detailed design budget cost estimates. 5) To show inflation trends which are then used in annual financial reports. 6) The HCCI is very important for understanding current trends when we go through the process of making a construction cost inflation forecast every January and June. "* |
| *"NDOT has utilized its construction cost index to assess construction cost trends. We have compared against FHWA cost index to compare our cost trends to nationwide trends. We are slowly increasing our use of our construction cost index. "* |
| *"Used as a blended independent data source vs a single estimator's data for estimates"* |
| *"For budgeting, Engineer's estimates and price comparisons"* |
| *"Pricing Indexes are used for Asphalt Cement Fuel"* |
| *"We calculate a asphalt price index based on the current prices for asphalt cement compared to price at time of letting."* |

Additional comments from the participants are tabulated in Table 2. One observation is that the FDOT has used HCCIs to evaluate the availability of highway construction materials in Florida and determine the future cost of construction materials, i.e., purchasing power.

Table 3. Additional comments on HCCI utilization

| |
|---|
| "*Three lowest bidders' unit prices are used to calculate HCCI. Items are grouped to calculate the HCCI. As an example, all P.G. Grades are grouped together to calculate the cost index for Asphalt Binder.*" |
| "*They are just one factor that FDOT uses to evaluate the availability of highway construction materials in Florida. The evaluation includes an analysis of the existing and planned supply of these materials, and an estimate of future costs and quantity requirements FDOT will face in fulfilling its five-year work program.*" |
| "*In case both files did not upload above in Q13, please see this link for a recent HCCI statement: https://www.dot.state.mn.us/bidlet/CostIndex/CostIndexQ42017.pdf*" |
| "*Indices are maintained as an integral part of a cost estimator's toolkit to evaluate and forecast market conditions that may influence PennDOT construction cost estimates.*" |
| "*I think multi-layered indices are the future, where state agencies have cost indices for items, item classes, divided by region and work type. Wisconsin's index uses a basket of 100 bid items, and only a third of item classes are represented. It is a Chained Fisher index. Data Analytics (currently under development by Infotech) may consider having a CCI module, so that more states can create their own indices using Data Analytics. *" |

## 2.3.11 State DOTs having HCCI user manual

Although 19 of the participating DOTs reported calculating their own HCCI, none of them reported maintaining their own HCCI user manual (see Figure 13). This implies that state DOTs have not been effectively documenting best practices for HCCI application. For instance, only three agencies have recently produced HCCI value publications or research publications. ARDOT reported having documented their HCCI calculation practice in the form of a guideline. In fact, HCCI uses have not been widely studied in state DOTs despite the fact that its first calculations date back to the 1980s.

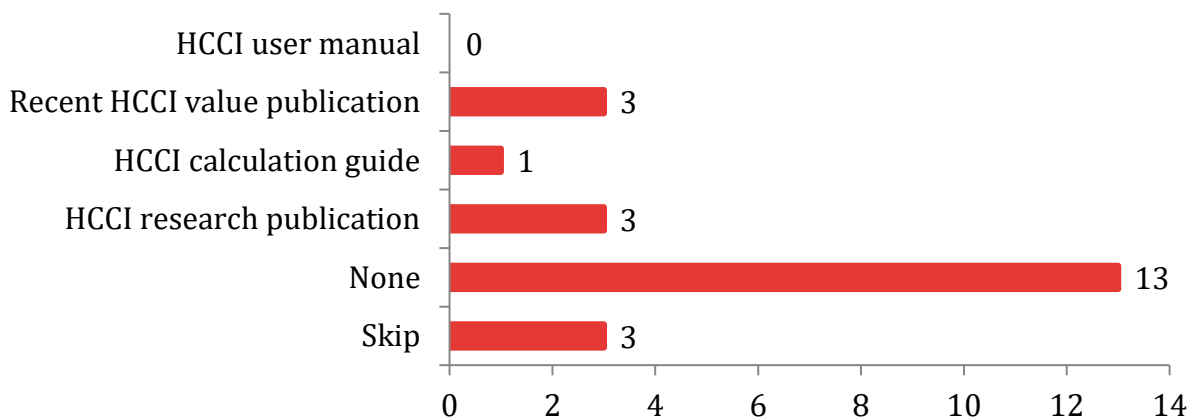

Figure 13. Publications on the topic of HCCIs

Three participants shared their HCCI documents. For example, Montana DOT provided an HCCI project report entitled, *Advanced Methodology to Determine Highway Construction Cost Index (HCCI)*: MnDOT shared a report entitled, *Highway Construction Costs and Cost Inflation Study*; and Ohio DOT provided their newly-published *HCCI Values for 2020 Q2*.

# 3. SURVEY ON MHCCI USE

## 3.1 Introduction

In addition to the national survey of federal and state DOTs, an internal survey was conducted within MDOT to identify MDOT's current practices and potential improvement with respect to the use of cost indices. Some notable objectives of the survey were to identify potential new uses of HCCI as well as to identify the priority of current uses in MDOT practice.

## 3.2 Survey design and administering

The research team developed a questionnaire designed to serve the survey objectives. The questionnaire was developed based on an extensive review of the literature on the use of HCCI as well as on the survey results of other states' HCCI use (described in Chapter 2). The steps followed by the research team in developing and administering the survey are as follows:

1. Develop a draft questionnaire that takes into consideration the HCCI uses identified in the literature review and nationwide survey results.
2. Obtain feedback from the RAP.
3. Conduct pilot survey.
4. Finalize the questionnaire based on the findings of the pilot.
5. Distribute the survey MDOT representatives via email.

The survey was distributed to MDOT representatives on September 4, 2020, via email, and we continued to accept responses until September 18, 2020. A reminder was sent out as a way of increasing the number of participants. During the survey period, nine responses to the MDOT survey were received.

## 3.3 Analysis of survey data

This section discusses the results of the MDOT survey.

### 3.3.1 Participating divisions/offices

The responses received spanned various offices/divisions, including Southwest Region Development/System Management, Planning, Regional Development for State DOT, Bridge, Superior Region/Ishpeming Transportation Service center (TSC), Region Development, and Design and Development (3 responses). The profile of the responses received reflects that the primary concern of MDOT regarding HCCI use is budgeting and estimation.

### 3.3.2 Current MDOT practice regarding cost inflation

The participants reported that their offices generally use an inflation rate of 4%, as specified by the FHWA and in the MDOT's CFP letter. Table 4 tabulates the various non-MHCCI approaches to accounting for inflation in cost estimation as reported by the respondents to the internal survey.

Table 4. Current practice of MDOT's office/division regarding cost inflation

| |
|---|
| *"We use the inflation factor provide by Planning in the CFP letter and increase the construction budget from the year programmed to the construction year."* |
| *"We use FHWA guidance of 4% annually. We also compare with Ohio DOT's construction cost forecast."* |
| *"Statewide planning unit responsible for distributing regional budgets and strategic guidance for the funded improvements. They issue the rate to be imbedded in future project budgeting."* |
| *"we monitor cost increases for bridge projects and use an multi-year average to adjust costs. We also use inflation to project future costs/declining purchasing power."* |
| *4% per year compounded annually."* |
| *"When scoping, the call for project letter dictates what we should use for annual inflation, which is 4%/year. This is a single line item in our scoping estimates. It is important to use good existing unit prices in these estimates as well which is more related to location and the specifics of each project."* |
| *"Shift program dollars between fix templates and between years to make up for shortfalls in current fiscal year budgets. Increase programmed budget amounts in future fiscal year projects to account for cost inflation. Scope projects with increased estimates."* |
| *"Typically follow Departmental direction supplied in our annual call for projects directions."* |
| *"Assume certain percentage of inflation by project obligation year to provide allowance for unit price increase."* |

When not employing MHCCI for calculating cost inflation, the planning division uses the FHWA guidance of a constant 4%/year inflation rate for long-range planning purposes. The

planning division also monitors other HCCIs, such as Ohio DOT's HCCI and NHCCI, as shown in Table 5. Other MDOT offices reported that they do not currently use any cost index.

Table 5. Descriptive uses of HCCIs or cost indices for MDOT

| |
|---|
| *"We compare Ohio DOT CC forecast with NHCCI and the FHWA guidance. state CCI's can be volatile, we prefer to use the FHWA guidance of constant 4%/year for long-range planning"* |
| *"Average unit prices are used to estimated present year cost of future projects. Then inflation factors used to estimate future year budget."* |
| *"Scoping future projects. Developing the region project selections based on future projects of project costs that fit into our budget. Determining project costs throughout all phases of the design."* |
| *"I do not use these now."* |
| *"We currently don't. We rely on past project per lane mile costs to calculate future year project costs for programming purposes. We rely on MDOT's bid based prices to determine project level estimates at project milestones. "* |
| *"Predicting project costs initially in long term planning.*<br>*Refining project costs as the design progresses. "* |
| *"Use MDOT guidance on inflation when putting together estimates."* |

### 3.3.3 HCCI aggregation levels for MDOT practice

MHCCIs are calculated at three aggregation levels: (1) overall state, (2) categorical, and (3) regional. The majority of MDOT offices reported using all types of calculated MHCCIs, as shown in Figure 14. The respondent from the planning division reported that their office would be open to using other cost indices (i.e., ENR Construction Cost Index)
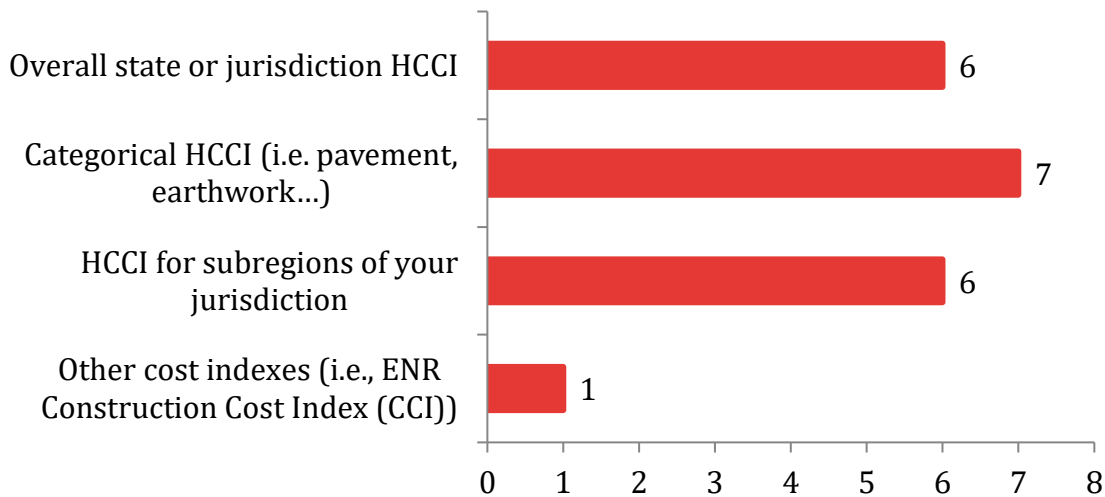


Figure 14. Uses of MHCCI at various aggregation levels

### 3.3.4 HCCI frequency for MDOT practice

Figure 15 presents the respondent preferences with respect to MHCCI granularity. As shown in the figure, most MDOT offices reported equal preference for quarterly and annual MHCCIs, with five counts for each. In this regard, it should be noted that, when the construction market encounters high fluctuations, quarterly HCCIs may be subject to chain drift, as discussed in Chapter 4. Instead, annual HCCIs should be used for monitoring and forecasting future inflation factors.
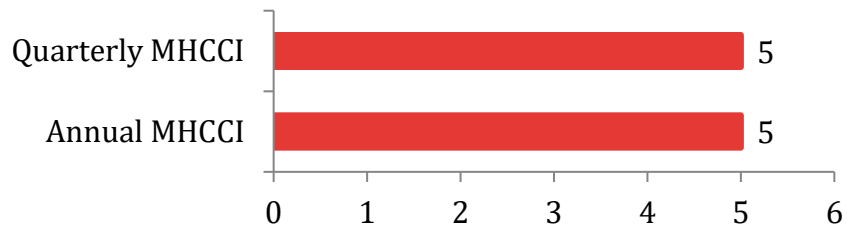


Figure 15. MHCCI frequency for MDOT

### 3.3.5 Prioritized potential HCCI uses

Table 6 tabulates the responses regarding primary uses of HCCIs by the MDOT. As shown in the table, the top three uses are (1) budgeting of construction projects, (2) scoping estimate, and (3) engineer's estimate. Only one participant reported using HCCIs for monitoring trends and HCCI forecast.

Table 6. Primary uses of HCCIs or cost indices for MDOT

| |
|---|
| *"Estimate project cost during design* *Estimate project budgets at scoping"* |
| *"recommend rate to MPOs for their comparison of estimated available revenues to project costs"* |
| *Preliminary Project Cost Estimating"* |
| *"budgeting* *forecasting"* |
| *"Budgeting construction projects for upcoming fiscal year(s) (program level)* *Preliminary cost estimation in early stages (project level)* *Engineer's estimate (project level) "* |
| *"Establishing scoping estimates.* *Engineer's estimates for early milestone submittals"* |

| |
|---|
| *"Budgeting construction projects in upcoming years* |
| *Preliminary cost estimation* |
| *Engineer's estimate"* |
| *"Predicting project costs initially in long term planning.* |
| *Refining project costs as the design progresses. "* |
| *"Budgeting for future projects* |
| *PE estimation* |
| *Historical Trends* |
| *Future inflation factors"* |

Participants also provided additional comments on potential HCCI uses, as summarized in Table 7. As can be seen, most of them concern the scoping estimate and engineer's estimate. In particular, respondents suggested that categorical and regional sub-HCCIs could be used to adjust the cost estimate for specific categories and regions so as to improve the accuracy and precision of the estimate.

Table 7. Other uses of MHCCIs for MDOT

| |
|---|
| *"Just for comparison to FHWA guidance of 4% annually."* |
| *"It would be nice to improve estimating for sub-regions. There are areas further away from the region's two asphalt plants that seem to be have high bids on a regular basis, but the trend isn't captured in the average prices. It would be ideal to avoid under estimating project costs in these areas."* |
| *"perhaps. depends if it is based on any of the work categories that influence bridge prices."* |
| *"Better estimating scopes for future projects especially 6 years out."* |
| *"This would be used in lieu of the standard inflation rate for generating scoping estimates. Standard base unit prices per region, with adjustments for local or specific conditions, would also be beneficial for more consistent scope estimates."* |
| *"I think the HCCI should influence our bid based prices as well as our per lane mile costs which we use to program future projects. It should influence our funding distribution between the Regions as the data clearly shows Metro and University cost indexes to have increased more than the other Regions."* |
| *"The current system seems to work quite well. Probably the biggest problem we run into is accurate costs for unusual items and regional adjustments in pricing. So perhaps calling on a larger pool of data to include other nearby states for the odd items would be useful."* |

# 4. MDOT STRATEGIC PLANNING OF HCCI USE

Leveraging the survey results and reviews of the academic literature and industrial reports regarding HCCI use, this chapter presents the proposed strategic plan for MHCCI use. The proposed strategic plan consists of prioritized uses and an implementation guide.

## 4.1 Prioritized Uses of MHCCIs

As shown in Figure 16, a number of uses of HCCIs, such as budgeting for upcoming fiscal years, scoping estimates, engineer's estimate, forecasting construction costs (i.e., inflation rate), and checking historical trends, were identified based on the nationwide and MDOT internal surveys as top uses of HCCIs.
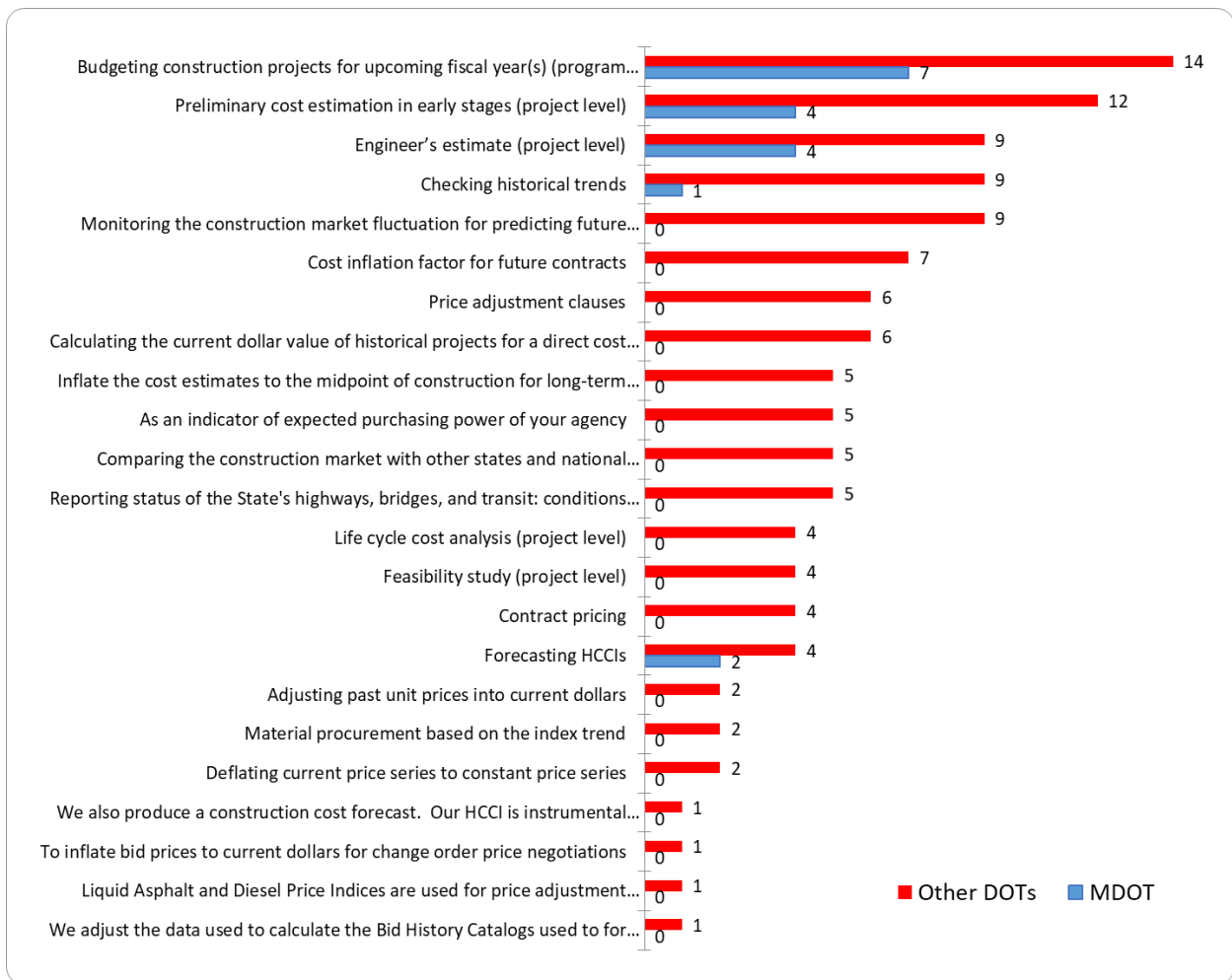


Figure 16. Frequency of HCCI use by DOTs

It is worth noting that the MDOT survey revealed that the primary uses of MHCCI in practice have been limited to budgeting for upcoming fiscal years, preliminary (i.e., "scoping") estimates, engineer's estimate, checking of historical trends, as well as forecasting construction costs (i.e., inflation rate). The reason for this limited use may lie in the fact that the participants in the MDOT internal survey are from the regional office, and as such their main concerns were related to program budgeting, preliminary estimate, and engineer's estimate, whereas no consultants or contractors participated in the survey.



Figure 17. Overview of MHCCI uses

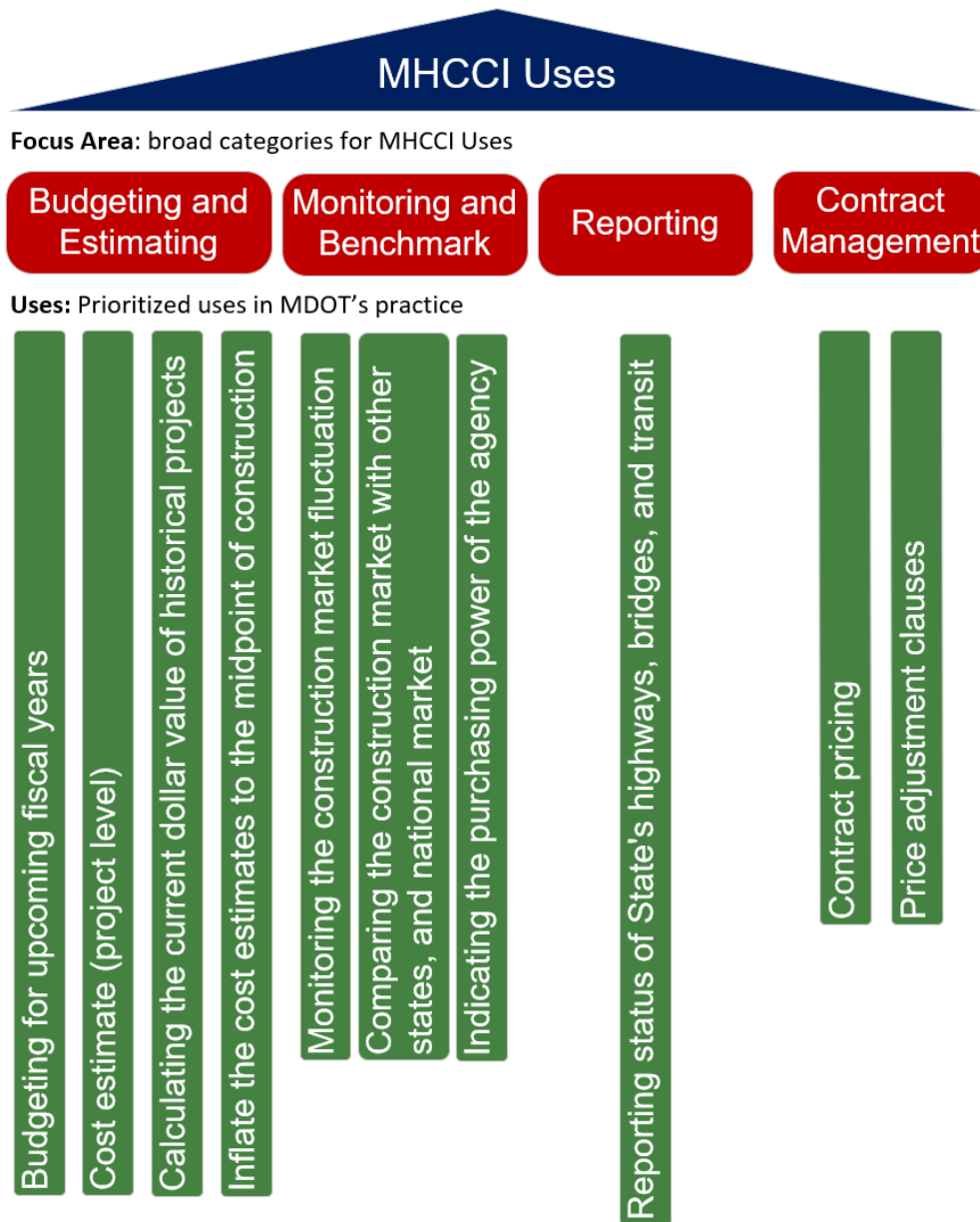The following sub-sections give an account of the use of MHCCIs in MDOT's current practice in ascending order of the identified priorities. They are categorized into four focus areas (see Figure 17): (1) budgeting and estimating, (2) contract management, (3) monitoring and benchmarking, and (4) policy development.

## 4.2 Budgeting and Estimating

### 4.2.1 Budgeting for upcoming fiscal years

Budgeting for upcoming fiscal years was identified in both surveys as the most popular use of HCCIs. Although DOTs follow a practical approach—for example, a 4% cost inflation rate—for budgeting, the use of HCCIs can improve the accuracy and precision of budgeting and estimation. For instance, Jeong et al. (2017) proposed to use the average growth rate over the past three to five years as the basis for the future inflation rate as a way of taking into account regional market conditions and changes in MnDOT's practice. (In the context of this report, it should be noted, the average growth rate is the year-over-year change in annual HCCI). Given that the MHCCI calculation tool can forecast the MHCCI for the next five years, MDOT, especially the regional offices, is **suggested** to make use of the predicted annual MHCCIs for budgeting purposes.

Specifically, the forecast year-over-year changes in annual HCCI should be used to express **current dollars** of cost estimates in **future dollars** at the midpoint of the construction period. In this regard, it is worth noting that:

1) The future dollar conversion should be based on the letting date and construction duration, as shown in Figure 18. This is in consideration of the fact that the term "future dollars" in planning and budgeting typically refers to the expenses at the **midpoint of the construction period**.

2) The predicted MHCCI values can be applied to calculate the cost of *standard pay items*. The is due to the fact that MHCCIs are computed based on standard pay items and can only reflect the price change for standard pay items.

3) The year-over-year changes in predicted MHCCI should be applied to the current dollar value of the estimate, which needs to be prepared based on the bid price of pay items in the preceding period (e.g., quarter and year). In this regard, the following sub-sections describe how to prepare a cost estimate using historical bid prices and calculated MHCCI values.
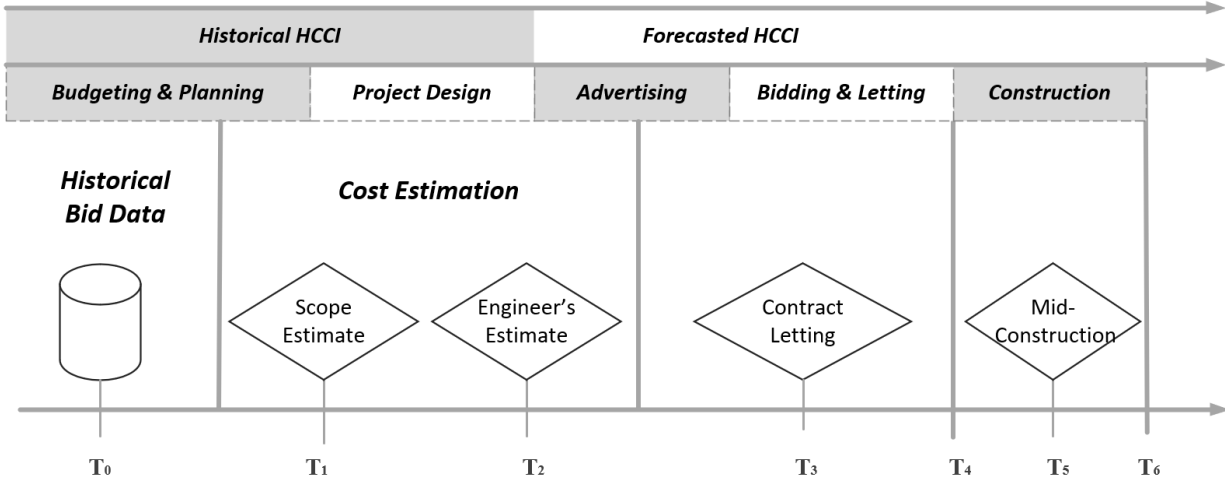
Figure 18. HCCI uses across the project life cycle

### 4.2.2 Cost estimation (project level)

Cost estimation (preliminary estimate and engineer's estimate) is the second-most popular use of HCCIs. In developing cost estimates, the historical price trend of pay items should be used as a reference. At times, the bid price of standard pay items in the preceding quarter may not be available because these pay items were not awarded in that quarter. For this reason, the historical bid price of these pay items has to be converted to the current dollar using the calculated MHCCIs. In this conversion, two steps can be carried out sequentially as follows:

1) Convert historical bid price of standard pay items to the current value using their corresponding categorical MHCCI

   o $Bid\ Price_{c,state} = Bid\ Price_p \times \dfrac{Categorical\ MHCCI_c}{Categorical\ MHCCI_p}$

2) Apply Region MHCCIs to account for sub-regional market condition

   o $Bid\ Price_{c,sub-region} = Bid\ Price_{c,state} \times \dfrac{MHCCI_{c,region}}{MHCCI_{c,state}}$

The resulting bid price of these standard pay items, i.e., $Bid\ Price_{c,sub-regsion}$ should then be used in the cost estimate, whether a preliminary estimate or engineer's estimate.

### 4.2.3 Calculating the current dollar value of historical projects

27

As observed in the nationwide survey results, several state DOTs, such as MnDOT and ODOT, also use HCCIs for calculating the present dollar value of historical projects. However, this use was not reported by MDOT survey participants, implying that it is a *low priority* for MDOT. However, the authors recommend that MDOT consider using HCCI for the current dollar value calculation. This is due to the fact that the current dollar value calculation is associated with cost estimation so that it assists estimators in deriving more accurate estimates by means of cost comparison.

### 4.2.4 Inflating the cost estimates to the midpoint of construction for long-term projects

Similarly, inflating the cost estimates to the middle of the construction period, which is particularly important for long-term projects, has not been a primary use of MHCCIs according to the MDOT internal survey. However, inflating the cost estimates to the midpoint of construction for long-term projects could be an important step in program budgeting and cost estimation. Once the current values of construction projects have been calculated, they can be further converted into future dollars at the **midpoint of the construction period**. In fact, future dollars at the midpoint of the construction period is a cost estimate with higher accuracy and precision for the program budgeting. It is suggested that MDOT could inflate the cost estimates to the midpoint of construction for long-term projects during budgeting.

### 4.3 Monitoring and Benchmarking

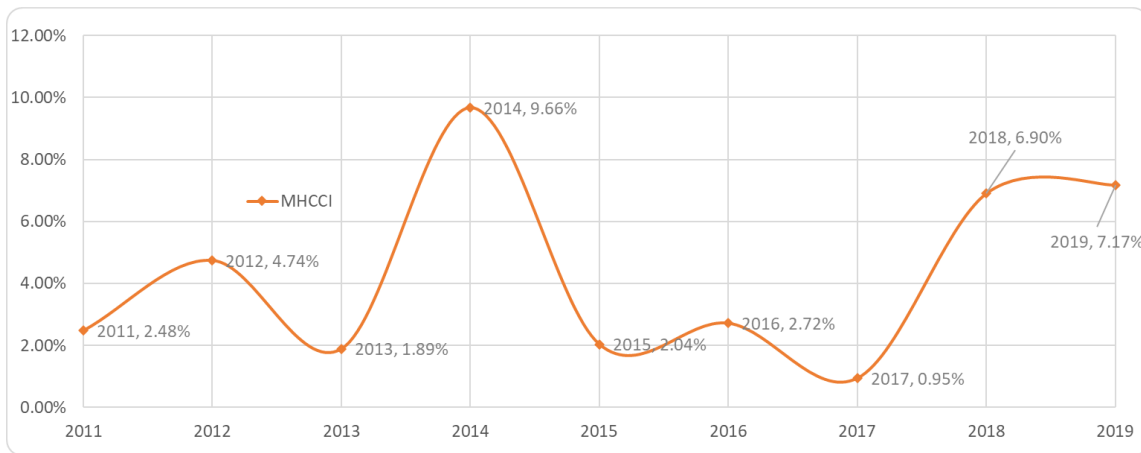### 4.3.1 Monitoring the construction market fluctuation

By definition, HCCI is designed to track the price changes of construction pay items over time, thus allowing for checking of historical price trends of pay items in the highway construction industry. Technically, HCCI is aggregated based on the bid price and quantity of pay items. In other words, the quantities of pay items awarded are used to weight the price changes of pay items in the HCCI calculation. In particular, the Fisher index formula continuously updates weights of bid items (i.e., quantities of both the base period and the current period) over time. The Fisher index can thus be used to track market fluctuations in terms of item quantities and bid prices.

Construction market fluctuations can be monitored through either of two approaches: (1) index trend visualization and (2) year-over-year change (growth) method. Figure 19 shows the

annual MHCCI trend and its year-over-year changes for Michigan. It is recommended that MDOT monitor the construction market by exploring the movements of the overall MHCCI, categorical MHCCIs, and sub-regional MHCCIs, as well as their year-over-year changes.
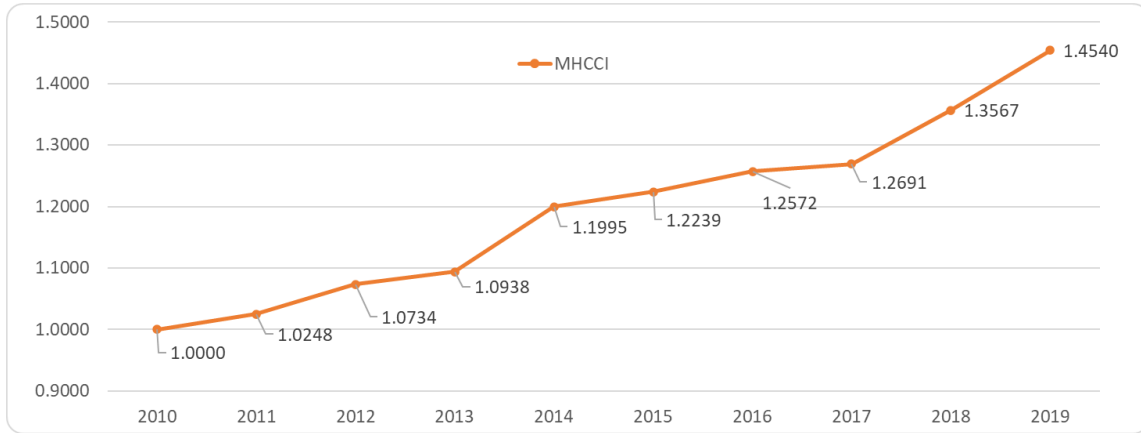


(a) Annual MHCCI



(b) Year-over-year change

Figure 19. Construction market fluctuation: (a) MHCCI trends and (b) year-over-year change

### 4.3.1.1 MHCCI trend

Quarterly MHCCIs reflect seasonal effects in the construction market. However, the quarterly MHCCIs suffer from chain drift bias when there is a high seasonal fluctuation in the construction market, i.e., fluctuations in quantities and bid prices (Jeong et al., 2017). In this respect, the MHCCI value may not be equal to one even if the prices and quantities of pay items in the current period have reverted to the original values from the base period (von Auer, 2019). For cases of

high fluctuation, it is ***recommended*** that the annual MHCCI trend be used to monitor these market fluctuations.

Sub-MHCCIs can provide insights into specific aspects of the highway construction market, such as trends with respect to particular regions and item categories. Sub-MCCIs allow DOTs to understand construction market conditions at a higher level of granularity and thereby more accurately monitor market fluctuations in particular regions. Categorical MHCCIs, meanwhile, can provide insights with respect to specific categories of highway construction, such as earthwork, base, HMA pavement, and so forth.

### *4.3.1.2 Year-over-year change in MHCCI*

On the other hand, the year-over-year change in MHCCI compares the index value for a given year to the previous year. The year-over-year growth rate calculates the percent change from the preceding year and is an effective mechanism for capturing annual growth. As such, MDOT ***should*** consider using MHCCI values to calculate year-over-year change, as expressed in the below equation, as a way of characterizing yearly market fluctuations.

$$\text{year-over-year change} = \frac{MHCCI_c}{MHCCI_{c-1}} - 1$$

where $c$ denotes the current period, and $c-1$ represents the previous period.

### 4.3.2 Comparing the construction market with other states' and national market

In addition to being used in the monitoring of Michigan's construction market trends, MHCCI can be used for construction market comparison between Michigan and other states and the national market. Three methods can be used for these comparisons, namely: (1) index trend visualization, (2) year-over-year change visualization, and (3) a statistical method, i.e., Pearson's correlation coefficient. Pearson's correlation coefficient is a variable ranging from 0 to 1, with higher values indicating a stronger linear relationship. In the context of price indices, a higher value is indicative of a higher degree of similarity in market conditions and changes in market conditions between the states under comparison for a given period of time.
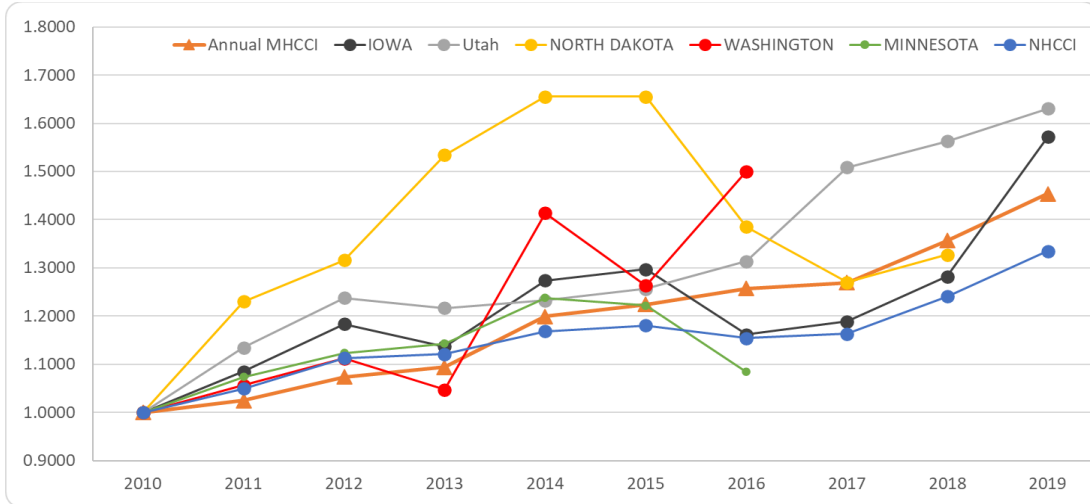
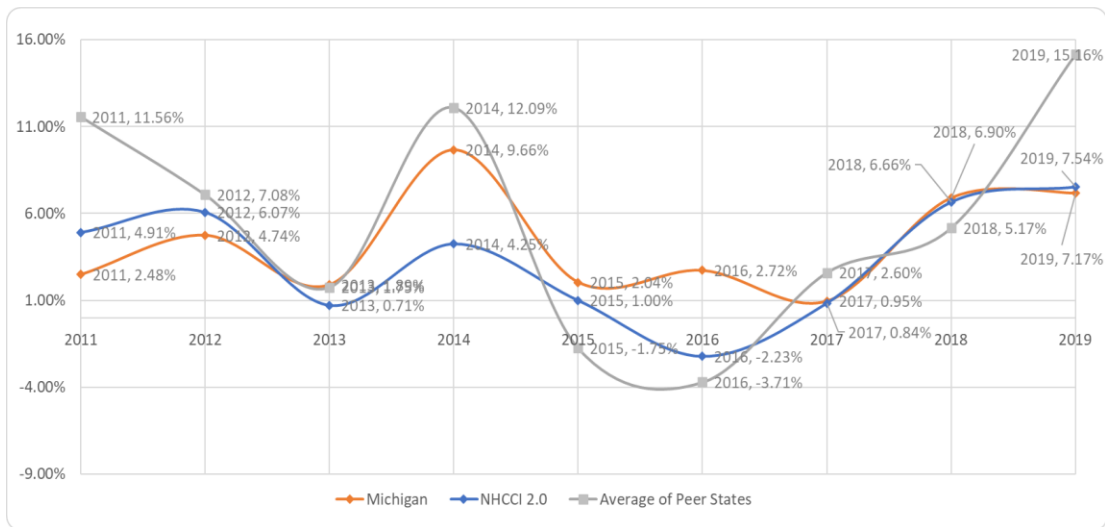Figure 20. Annual MHCCI, peer states' average HCCI, and NHCCI 2.0



Figure 21. Year-over-year change in MHCCI, peer states' average HCCI, and NHCCI 2.0

For example, Figure 20 and Figure 21 show the HCCI trend and year-over-year change for Michigan, for the FHWA (i.e., NHCCI 2.0), and for the peer states. All the peer states considered, with the exception of North Dakota, exhibited a similar HCCI trend with Michigan, as did the FHWA NHCCI 2.0, suggesting similar construction market conditions.

As revealed in the statistical analysis, the annual HCCI trend of North Dakota is following the annual MHCCI with a time lag of one year, while Utah's and Minnesota's annual HCCI trends are following the annual MHCCI with a two-year lag. Statistically, this observation suggests that the effect of regional construction market conditions may be first observed in Michigan, Iowa, and

31

Washington, among the peer states, followed by North Dakota, and, finally, Utah and Minnesota. In addition, statistical results suggest that the quarterly MHCCI is following the asphalt and tar pavement mixture PPI with a two-quarter (i.e., half-year) lag.

Therefore, MDOT *should* consider adopting the use of quarterly and annual MHCCIs for such comparisons as a way of obtaining insights into local construction market trends and anticipating future trends.

### 4.3.3 HCCI as an indicator of the purchasing power of the agency

HCCI can also be used to gauge purchasing power. According to the nationwide survey on HCCI use, many state DOTs, such as INDOT and ODOT, use HCCIs to measure purchasing power. It is also recommended that MDOT make use of MHCCIs for such purposes. For example, the annual MHCCI in 2019, with the base year of 2010, is 1.4540. This means that MDOT would need $1.4540 in 2019 to purchase a construction service that cost $1 in 2010. In other words, that dollar has 31.2% (i.e., 0.454/1.454) less purchasing power in 2019 than in 2010.

### 4.4 Reporting

### 4.4.1 Reporting status of State's highways, bridges, and transit

Several state DOTs, such as ODOT and FDOT, have also employed HCCIs to report on the construction status of highways, bridges, and transit. In this regard, MHCCIs would allow MDOT to become better informed about local construction market conditions and fluctuations. In particular, the comparison results with major construction material Product Price Index and peer states' HCCs could provide insights into the local market. Therefore, it is suggested that MDOT use the quarterly and annual MHCCIs for reporting. For example, MDOT could provide quarterly MHCCIs as requested by the house and senate transportation appropriations sub-committee.

### 4.5 Contract Management

### 4.5.1 Contract pricing

As described above, the MHCCI calculation tool is capable of forecasting the MHCCI for the next five years; it is **recommended** that MDOT, especially its regional offices, make use of the predicted annual MHCCIs as a cost inflation factor for future contracts.

## 4.5.2 Price adjustment clauses

Pierce et al. (2012) reported that categorical HCCIs (e.g., steel, asphalt, concrete, and fuel) and item-level HCCIs could be used for price adjustment clauses in contracts. When the unit prices of such items as fuel, asphalt, etc. change beyond a threshold value, e.g., 5%, price adjustment clauses allow contractors to be compensated (Jeong et al., 2017). As a result, these clauses transfer the risks of price volatility from contractors to state DOTs. In turn, bidders will tend to submit a lower bid due to the reduced level of risk. However, at present, MDOT is not utilizing any price adjustment clauses (AASHTO Subcommittee on Construction, 2016). This use of HCCIs was not reported in the MDOT survey, implying *its low priority* in MDOT's practice. It is recommended that MDOT consider incorporating price adjustment clauses into construction contracts and utilizing categorical HCCIs to define the price adjustment clauses.

## 4.6 Departmental Collaboration and Support

Given that the HCCI calculations and uses described above involve multiple offices across departments, it is imperative that these offices/divisions collaborate closely to ensure effective implementation of HCCIs in MDOT's practice, as shown in Figure 22. For example, DTMB support staff from construction field services need to extract historical bid data into the Excel file for the MHCCI calculation. The design division then uses the developed MHCCI tool, along with the extracted data, to calculate and forecast MHCCI values. The MHCCI historical values and forecast are, in turn, distributed to regional offices via annual project meetings. Leveraging the MHCCI historical values and predictions, the regional offices can prepare cost estimates for project planning and design, such as scoping estimate and engineer's estimate. Following this, the design division can determine the contract price, while Finance Contract Services Division can use HCCIs to report on the construction status of state highway and bridge projects.
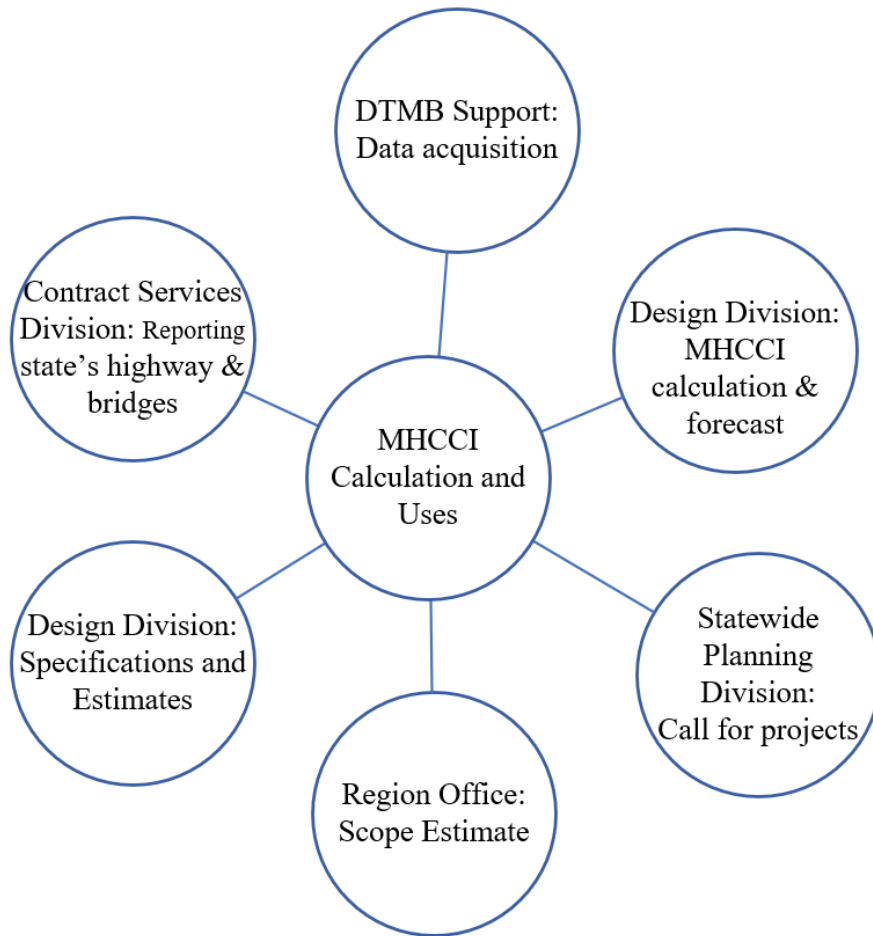
Figure 22. Organizational offices for MHCCI development and uses

# 5. CONCLUSION AND RECOMMENDATIONS

The main objective of this study was to identify best practices for HCCI use and develop a strategic guideline for applying HCCI in MDOT's practice, with emphases on future budget needs, cost estimating techniques, and project scoping. Having investigated best practices for HCCI use through surveys, we provide the following recommendations for the prioritized use of MHCCIs.

1. *Budgeting for upcoming fiscal years:* It is **recommended** to make use of the predicted annual MHCCIs as a means of converting the current dollar amount of pay items into future dollars when budgeting. It is worth noting that the predicted MHCCI values can be applied to the price of ***standard pay items***, rather than non-standard pay items such as right-of-way items. The future dollars should be calculated for the mid-point of the construction period, especially for long-term projects.

2. *Cost estimating:* When the bid price of standard pay items in the preceding quarter may not be available, the historical bid price of standard pay items should be converted to the current value using Categorical MHCCIs and Regional MHCCIs.

3. *Project scoping:* All regions should be given with the inflation rate for the next five years based on the predicted annual MHCCIs. Leveraging the predicted MHCCIs, all project estimates should, for scoping estimate purposes, reflect future year dollars.

4. *Maintaining MHCCIs:* A dedicated MDOT official should be designated to manage and maintain the MHCCI using the developed MHCCI tool.

In addition, the ARIMA model and the Seasonal ARIMA model were employed in the developed MHCCI tool to predict the HCCI for the next five years. However, with the ongoing pandemic and economic recession, which are not considered in the model, those forecasts should be considered with high caution. With the availability of more cost data for the ongoing pandemic and economic recession, the ARIMA model and the Seasonal ARIMA model should be further investigated in terms of the prediction accuracy. The developed MHCCI tool also needs to be improved, provided that MDOT makes significant structural changes to the specification book.

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# APPENDIX A: NATIONWIDE SURVEY ON HCCI USE

**Cover Letter**

Hello!

The Michigan Department of Transportation (MDOT) is interested in understanding how other agencies like yours have utilized Highway Construction Cost Indexes (HCCIs). MDOT has contracted with Western Michigan University (WMU) to develop a Michigan HCCI and research its application.

The survey WMU developed will take about 10 minutes to complete. If you think another person in your agency is best suited to provide feedback, please do not hesitate to forward this survey to them. If possible, please complete the following survey by July 15, 2020.

Should you have any questions, you can contact Dr. Hexu Liu at (269) 276-3201 or email hexu.liu@wmich.edu.

Thank you!

1.  Does your agency use a construction cost index?
    ☐ Yes
    ☐ If No - go to Q14

2.  Does your agency calculate its own Highway Construction Cost Index (HCCI)?
    ☐ Yes
    ☐ If No - go to Q5

3.  How frequently does your agency calculate the HCCI?
    ☐ Quarterly
    ☐ Annual
    ☐ Monthly
    ☐ Semi-annual

4.  What level of HCCI is calculated by your agency?
    ☐ Overall state or jurisdiction HCCI
    ☐ Categorical HCCI (i.e., pavement, earthwork…)
    ☐ HCCI for subregions of your jurisdiction
    ☐ Materials HCCI (i.e., Concrete, HMA, Steel)
    ☐ Other _____

5.  Does your agency use any other HCCIs (peering states or FHWA) or third party cost indices?
    ☐ Yes
    ☐ No (if no, proceed to Q8)

6.  What are the other cost indices used by your agency?
    ☐ National Highway Construction Cost Index (NHCCI)
    ☐ Engineering News-Records (ENR) Building Cost index (BCI) or Construction Cost Index (CCI)
    ☐ RSMeans City Cost Index
    ☐ Bureau of Labors Statistics (BLS) Producer Price Index (PPI)
    ☐ Regional Economic Models, Inc. (REMI) (REMI) model index
    ☐ Global Insight
    ☐ Parsons Brinckerhoff's Highway Construction Cost Index
    ☐ Turner Construction Company Cost Index
    ☐ Other _____

7.  How does your agency use the other cost indices?
    ☐ Side by side comparison of the indices with the in-house HCCI
    ☐ As a replacement of HCCI to determine an inflation rate of construction projects
    ☐ Other _____

8. Who are current users of HCCIs calculated or monitored by your agency? (all using HCCI)
   ☐ Planning
   ☐ Design or development
   ☐ Construction
   ☐ Operations
   ☐ Contracts
   ☐ Consultants
   ☐ Contractors
   ☐ Other _____

9. What are the main uses of the HCCIs calculated or monitored by your agency?

---

**Project planning & budgeting**
   ☐ Life cycle cost analysis (project level)
   ☐ Feasibility study (project level)
   ☐ Budgeting construction projects for upcoming fiscal year(s) (program level)
   ☐ Other (please list) _____

---

**Contract management**
   ☐ Contract pricing
   ☐ Cost inflation factor for future contracts
   ☐ Price adjustment clauses
   ☐ Other (please list) _____

---

**Cost estimation tool**
   ☐ Preliminary cost estimation in early stages (project level)
   ☐ Engineer's estimate (project level)
   ☐ Inflate the cost estimates to the midpoint of construction for long-term projects
   ☐ Other (please list) _____

---

**Construction management**
   ☐ Material procurement depending on the index trend
   ☐ Other (please list) _____

---

**Benchmarking**
   ☐ Calculating the current dollar value of historical projects for a direct cost comparison
   ☐ Checking historical trends
   ☐ Forecasting HCCIs
   ☐ Deflating current price series to constant price series
   ☐ Other (please list) _____

---

**Monitoring**

☐ As an indicator of expected purchasing power of your agency

☐ Monitoring the construction market fluctuation for predicting future market condition

☐ Comparing the construction market with other states and national construction market

☐ Other (please list) _____

**Policy development**

☐ Status of the State's Highways, Bridges, and Transit: Conditions and Performance (report to the House)

☐ Developing responses to policy issues related to employment and materials usage

☐ Calculating the gas tax percentage by the state

☐ Other (please list) _____

**Other**

☐ List any other uses not listed above_____

10. Please describe how you use HCCI for the purposes selected in Q9.

_____
_____
_____

11. Does your agency have any of the following documents?

☐ HCCI user manual – go to Q12

☐ Recent HCCI value publication – go to Q12

☐ HCCI calculation guide – go to Q12

☐ HCCI research publication – go to Q12

☐ None – go to Q13

12. If you are able to share your documents noted above, please upload the documents or a document with links.

☐ Upload

13. Please provide any additional comments about the utilization of HCCIs if any.

_____

14. How does your agency consider inflation in cost management?

_____
_____
_____

15. What is your agency?

_____

16. Can we contact you for further details about the information you provided in the questionnaire
if needed?
☐ Yes
☐ No

17. Contact information

Name:_____
Title:      _____
Email:      _____
Phone:_____

## APPENDIX B: STATEWIDE SURVEY ON MHCCI USE

Hello!

MDOT has contracted with Western Michigan University (WMU) to develop a Michigan Highway Construction Cost Indexes (HCCIs) and research its application.

**Survey Objective**:

This survey is to collect your opinion on how your office/division could utilize HCCIs values in your practice.

**Status of Michigan Highway Construction Cost Indexes (MHCCI)**

Currently, the WMU team has developed a computer tool, which is capable of calculating Michigan HCCI at various levels of aggregation. Given the historical pay item data for the period of 2010-2019, **quarterly and annual** HCCIs have been calculated at **overall state, item category, and MDOT region** levels. In specific, quarterly HCCIs were calculated for the overall state, ten pay item categories (e.g., Earthwork, HMA, etc.). In contrast, annual HCCIs were computed for the Michigan state, ten pay item categories, and MDOT regions. Also, the developed HCCI tool can make the predictions of HCCIs (i.e., both quarterly and annual HCCI for the overall state) for the **next five years**.

**Other Cost Indexes Available**

In addition to MHCCI, there are several other cost indexes typically used in the highway construction industry, such as (1) National HCCI, (2) Engineering News-Records (ENR) Building Cost Index (BCI) or Construction Cost Index (CCI), and (3) Bureau of Labors Statistics (BLS) Producer Price Index (PPI). These can be accessed differently - the tool developed in this research focuses on MHCCI only.

**How Other State DOTs Use HCCI**

As part of this research, WMU surveyed other states and FHWA. Figure 1 on the following page shows the primary uses of HCCIs in other DOTs. The bar number represents the number of state DOTs utilizing HCCI for the respective purpose. As shown in the figure, budgeting for fiscal years, preliminary cost estimation, engineer's estimate, checking historical trends, and monitoring construction market fluctuation are the most common uses of HCCIs.

**Other Information**

Given this information, please answer the following questions by September 15, 2020. This survey WMU developed will take about 10 minutes to complete.

Should you have any questions, you can contact the Principal Investigator, Dr. Hexu Liu at (269) 276-3201 or email hexu.liu@wmich.edu or the Project Manager, Kristi Kirkpatrick at (517) 335-1895 or email kirkpatrickk2@michigan.gov.

Thank you!

1. What is your office/division? E.g., Planning, Design and Development, etc.

   _____

2. Would you please describe the current practice of your office/division regarding cost inflation?

   _____
   _____
   _____
   _____

3. Which indices could be used by your office/division?
   ☐ Overall state or jurisdiction HCCI
   ☐ Categorical HCCI (i.e., pavement, earthwork…)
   ☐ HCCI for subregions of your jurisdiction
   ☐ Other cost indices (i.e., ENR Construction Cost Index (CCI))

4. What indices could be used by your office/division?
   ☐ Quarterly HCCI
   ☐ Annual HCCI

5. What are the primary uses of HCCIs or cost indices for your office? Please prioritize them in the descending order.

   _____
   _____
   _____
   _____

6. Would you please describe how you currently use HCCI or cost indices for the purposes selected in Q5?

   _____
   _____
   _____
   _____

7. Given that MDOT has its own HCCI, how would you like to use it in your future practices?

   _____
   _____
   _____

8. Contact information

   Name:_____
   Title:      _____
   Email:_____
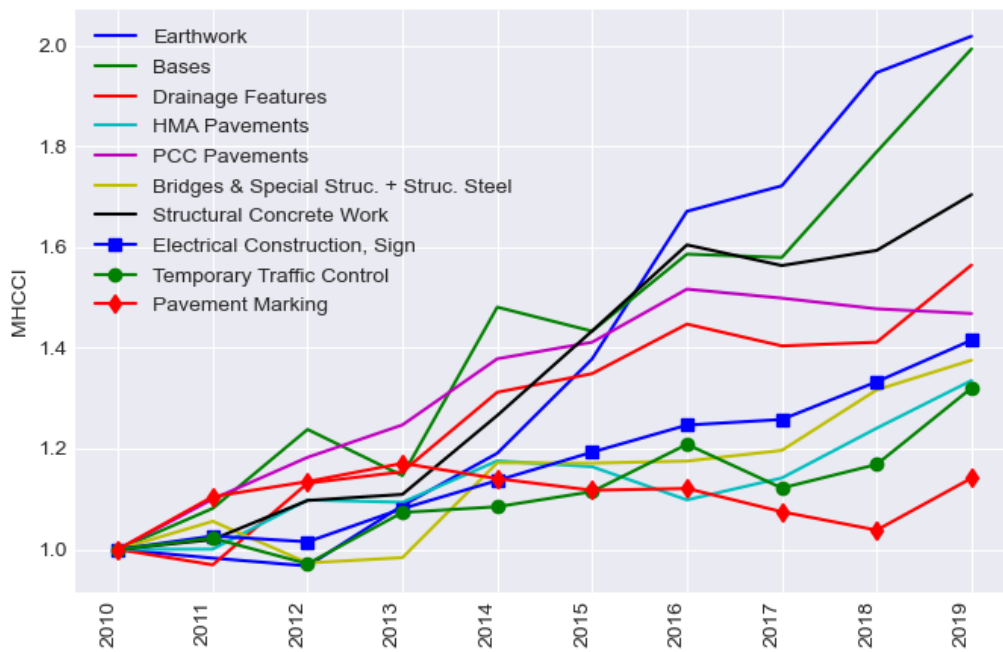   Phone:      _____

**APPENDIX C: USER MANUAL OF MHCCI TOOL**

# MHCCI Calculation Tool

# USER GUIDE

Last updated on October 15th, 2020

# TABLE OF CONTENT

## 1. GETTING STARTED

### 1.1 Introduction

MHCCI Calculation Tool is a standalone windows form application that can be used to calculate the Michigan Highway Construction Cost Index (MHCCI) at various aggregation levels (i.e., overall state, categorical, and sub-regional indices) based on historical price data of pay items. Also, it allows for forecasting the MHCCI values for the next five years and visualizing the price trends of pay items.

### 1.2 Installation

The latest versions of the MHCCI Calculation Tool are available for download from this link.
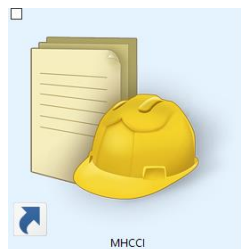
If you see this window during installation, click on More info and then Run anyway.
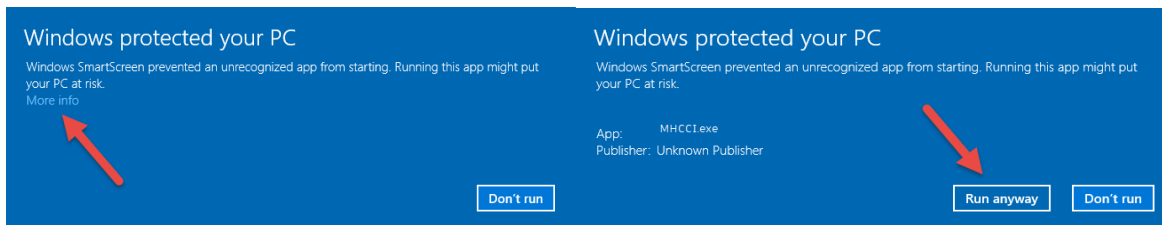


*Figure 1. Message box during MHCCI tool installation*

### 1.3 Run the Tool

Once the tool is installed successfully on your computer, you can find the icon on your desktop, as shown in Figure 2. Please double click this icon to run the tool.



*Figure 2. Desktop shortcut for the MHCCI tool*

**2. GRAPHIC USER INTERFACE**

The GRAPHIC USER INTERFACE (GUI) of the MHCCI calculation tool is presented in Figure 3. As shown in the figure, there are **five** functional components, including:
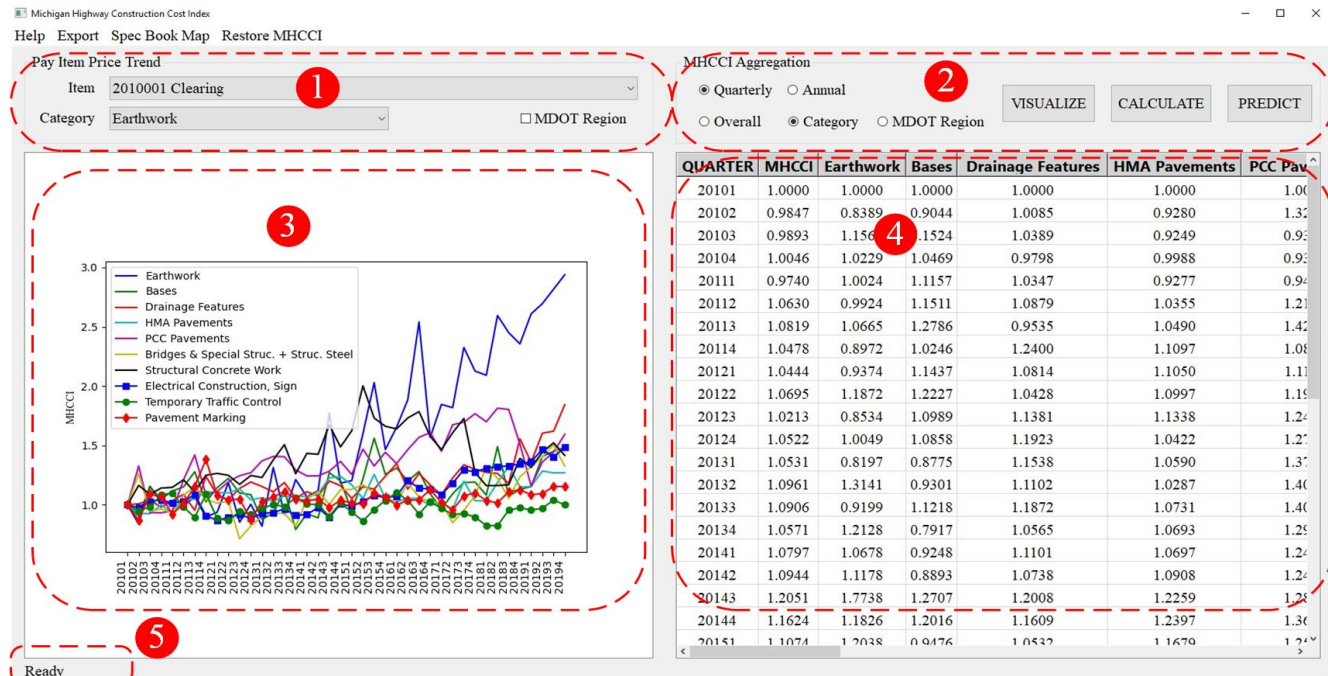


*Figure 3. GUI of the developed MHCCI tool*

1) Two drop-down lists for visualizing bid price trends (marked as 1)
   a) 'Category' dropdown list, which contains all item categories defined in **Table 1**

      i) When an item category is chosen, all pay items in this category will then be listed in the 'Item' drop-down list above.

   b) 'Item' dropdown list, which contains the item number and its description of pay items for the selected item category, except **Non-standard items**

      i) When a pay item is selected in the drop-down list **AND** MDOT Region is **unchecked**, the trend of the selected pay item's **quarterly bid price** will be displayed in the visualization area (i.e., the left-middle panel of GUI). Meanwhile, the selected pay item's **quarterly bid prices** will be tabulated in the table area (i.e., the right-middle panel of GUI). The item description will also be shown in the drop-down list.

      ii) When a pay item is selected in the drop-down list **AND** MDOT Region is **checked**, the **annual bid price** of the selected pay item for **each region** will be displayed in the visualization area (i.e., the left-middle panel of GUI). These annual bid prices of the selected pay item will be shown in the table area (i.e., the right-middle panel of GUI)

Table 1. Item category for sub-MHCCI

| Category | Item Numbers (first three digits) |
| --- | --- |
| Earthwork | 201, 202, 203, 204, 205, 206, 207, 208, 209 |
| Bases | 301, 302, 303, 304, 305, 306, 307, 308 |
| Drainage Features | 401, 402, 403, 404, 405, 406 |
| HMA Pavements | 501, 502, 503, 504, 505, 506 |
| PCC Pavements | 601, 602, 603, 604, 605 |
| Bridges & Special Struc. + Struc. Steel | 704, 705, 706, 707, 710, 711, 712, 713, 717, 718 |
| Structural Concrete Work | 701, 708, 801 802, 803, 804 |
| Electrical Construction, Sign | 810, 819, 820, 826 |
| Temporary Traffic Control | 812 |
| Pavement Marking | 811 |
| Others | All other items |

2) An MHCCI aggregation panel (marked as 2), which allows users to configure the frequency and aggregation level of MHCCI for visualization, calculation, and prediction

   a) Once the aggregation level (i.e., overall state, category, and MDOT region) and the frequency (i.e., quarterly and annual) are selected, the MHCCIs can be visualized, calculated, and forecasted by clicking corresponding buttons in this panel.

   For example, suppose 'Quarterly' and 'Category' are chosen. In that case, the quarterly MHCCIs for each item category can be visualized by clicking 'VISUALIZE' in the left-middle panel (marked as 3) in a graphic manner and the right-middle panel (marked as 4) in a tabular format.

3) A chart (marked as 3), intended to display the trends of pay items' bid price and MHCCIs.
4) A tabular form (marked as 4), allowing to check the numerical value of MHCCIs and bid prices.
5) A status bar (marked as 5), showing the operation status of the MHCCI tool, such as Ready, Calculation in Progress, Calculation is completed, and so forth.

Besides, there are **four** tabs at the top of the GUI, including:

1) 'Help' that provide basic information about this tool and the access to this user guide
2) 'Export,' which allows users to export the calculated and/or predicted MHCCIs into an Excel file and the chart in *.png*.
3) 'Spec Book Map', allowing to edit the map of various versions of SPEC BOOK in Excel.
4) 'Restore MHCCI'. This tab is developed for dropping the newly calculated MHCCIs if you input the wrong data into the MHCCI tool by mistake.

## 3. VISUALIZING DATA

The MHCCI tool is preloaded with the historical bid data and calculated MHCCI results. As such, it allows users to visualize the trends of each pay item's bid price and the calculated MHCCIs.

### 3.1 Bid Price of Pay Item

As shown in Figure 4, pay items and item categories are listed in the drop-down lists. The price trend of the selected pay item will be shown in the visualization area by selecting the item number. For example, the item category 'Bases' and the item number '3010003' are selected; then, its bid price trend is displayed in the chart area.
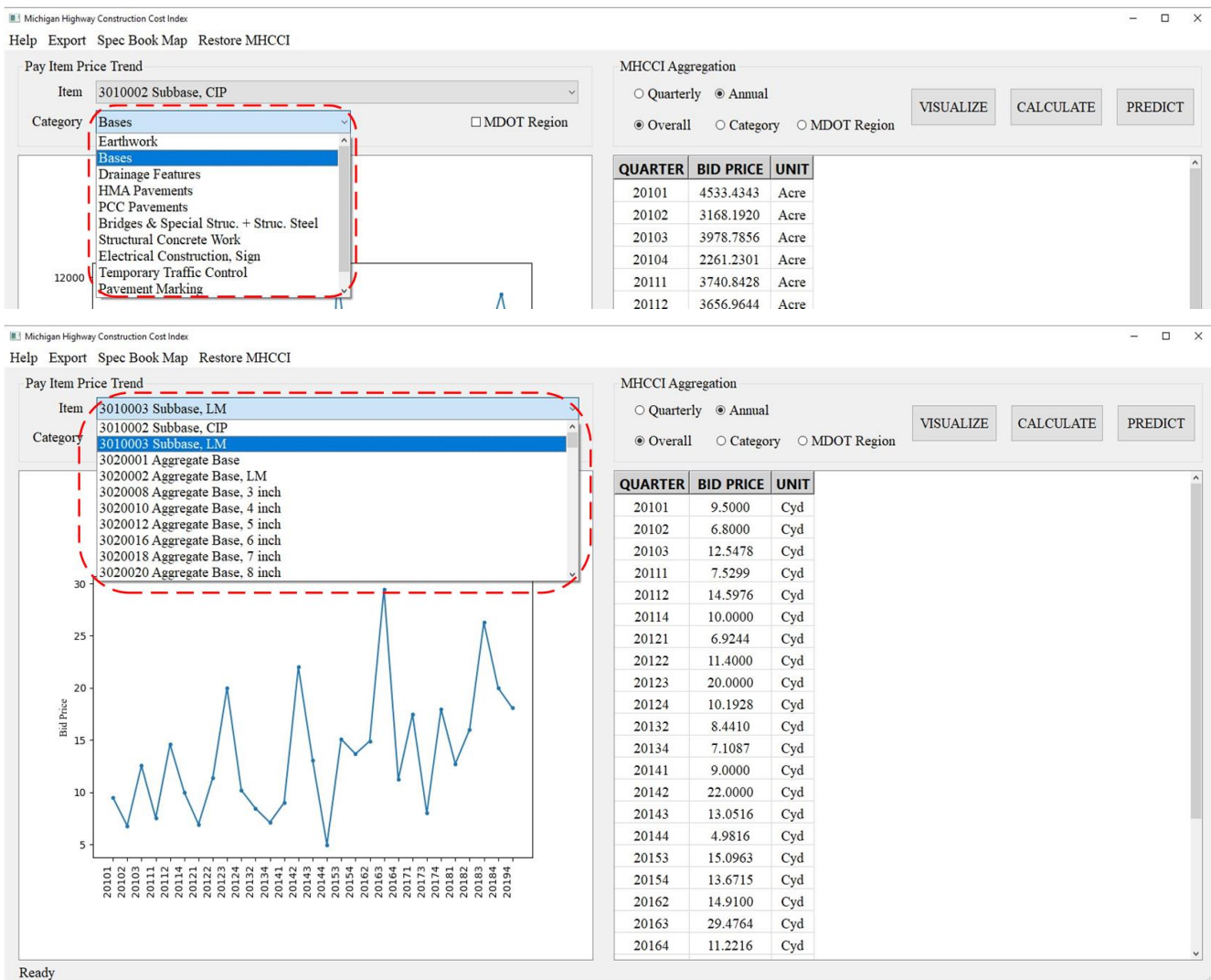


*Figure 4. The drop-down list of pay items*

### 3.2 MHCCI and sub-MHCCIs

The MHCCI aggregation panel enables users to configure MHCCIs at various aggregation levels and its frequency. The panel includes two radio groups (See Figure 5). The upper radio group is composed of two radio buttons, i.e., "Annual" and "Quarterly," whereas the lower group provides three options, namely: "Overall," "Category," and "MDOT Region." The combination of these two radio groups will allow users to visualize, calculate, and predict corresponding MHCCIs.

For example, if "Quarterly" and "Category" are selected, clicking 'VISUALIZE' will display the quarterly categorical MHCCI in the middle panels of GUI, i.e., a graphical trend on the left and numerical numbers on the right. It is worth noting that the combination of the "Quarterly" button and the "MDOT Region" button is not allowed, as regional MHCCI is only calculated at a frequency of year.
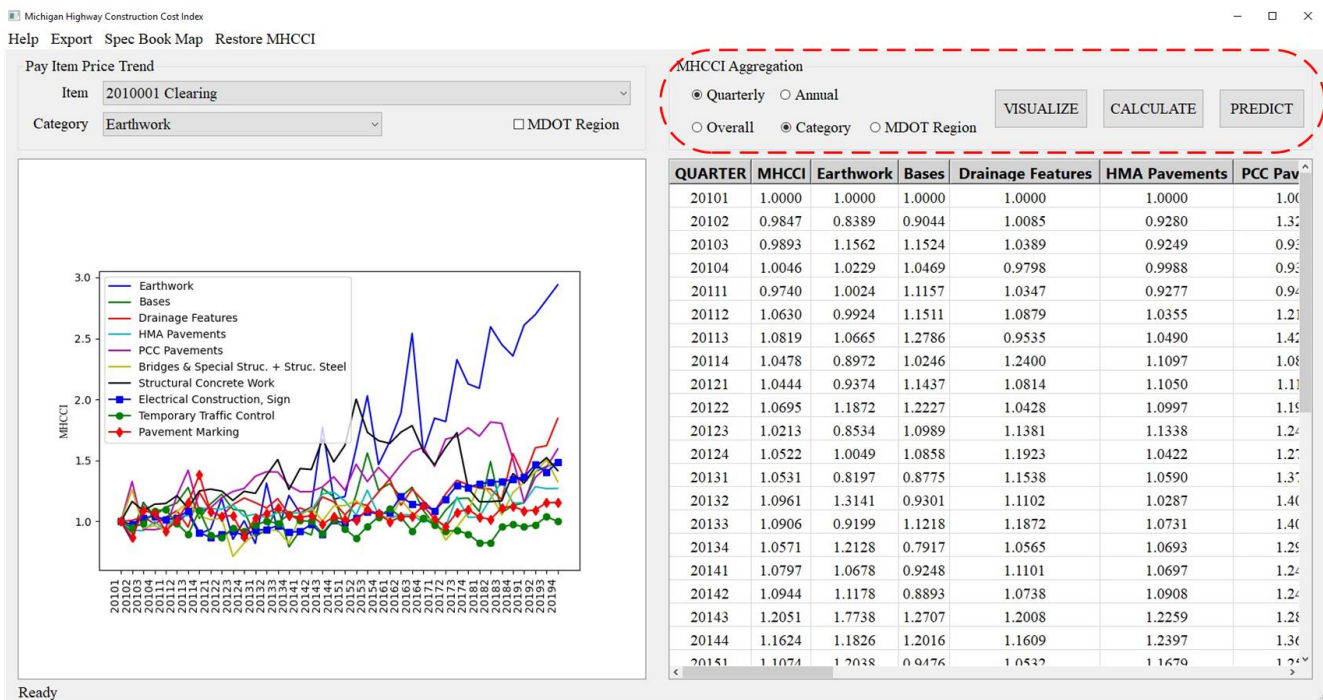


*Figure 5. MHCCIs Visualization on the GUI*

**4. CALCULATING MHCCIs**

**4.1 Importing New Data**

As new data is available for the quarterly and/or annual MHCCI calculation, those new data need to be imported into the MHCCI tool by clicking 'CALCULATE' on the GUI. The developed MHCCI tool can take data from MS Excel files. **It should be noted that** the Excel files should have all data attributes (as tabulated in Table 2) to enable the MHCCI calculation. In addition, formats of data attributes are also summarized in the table.

**Table 2.** Data attributes in pay item datasets

| ID | Description | Data Format | ID | Description | Data Format |
|----|-------------|-------------|----|-------------|-------------|
| 1 | LETTING DATE | Date | 11 | ITEM CLASS | General |
| 2 | CONTRACT NUMBER | General | 13 | ITEM TYPE | General |
| 3 | AWARDED AMOUNT | Currency | 16 | ITEM QUANTITY | Number |
| 5 | DISTRICT | General | 17 | UNIT | General |
| 7 | ITEM SPEC BOOK | General | 18 | BID PRICE | Currency |
| 8 | ITEM | General | 19 | EXTENDED AMOUNT | Currency |
| 9 | DESCRIPTION | General | 20 | VENDOR RANKING | Number |
| 10 | SUPPLEMENTAL | General | 22 | ITEM SPEC BOOK | General |

If "Annual" in the MHCCI Aggregation panel is selected AND 'CALCULATE' is clicked, a message box will be shown to the users, stating that '**Please import all available pay item data for the year after XXX**'.

On the contrary, if "Quarterly" in the MHCCI Aggregation panel is selected AND 'CALCULATE' is clicked, another message box will be popped up, stating that 'Please import all available pay item data for the **calendar quarters** after XXX' (**See Figure 6**).
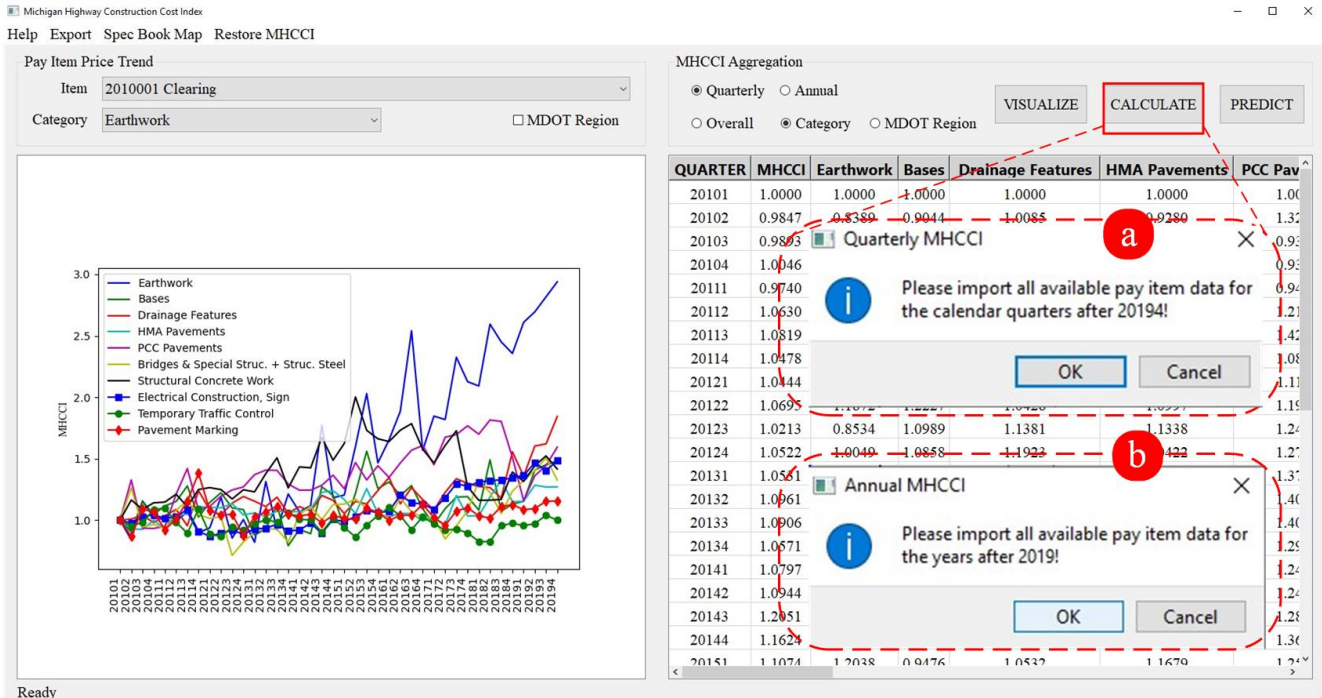
*Figure 6. Message box for MHCCI calculation and data import*

To import new data, please click on the "OK" button in the message box marked as *a* and *b* in Figure 6. A file dialog will then be popped up for the user to browse an MS Excel file (See Figure 7).
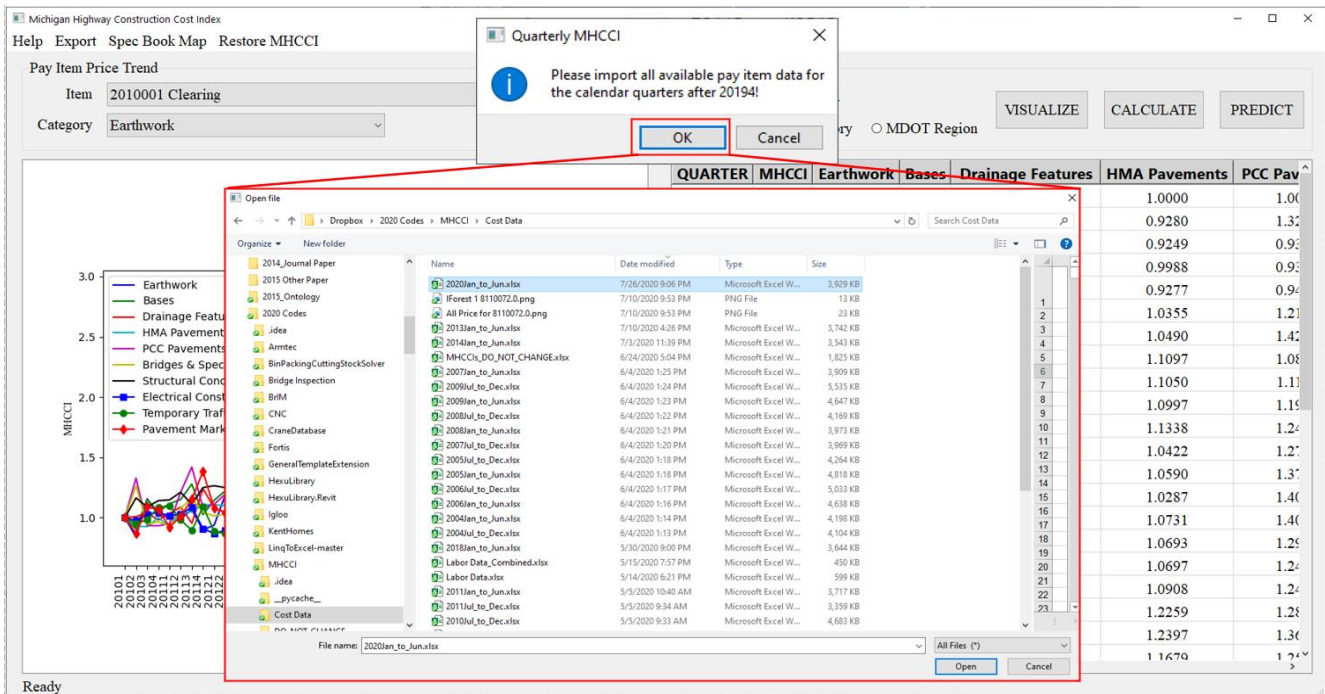


*Figure 7. Pay item data import for MHCCI calculation*

**Note:**

- When calculating new quarterly MHCCIs, users need to save bid data of **whole quarters** in **one single MS Excel file** and import the file into the MHCCI tool.
  - The excel files have to be imported in the chronology order. For example, the Excel file with the bid data for the period of 2020 Q1 has to be imported into the tool before the Excel file with the bid data for the period of 2020 Q2.
- Similarly, the user has to save **whole years' bid data** in **one single MS Excel file** and import it into the MHCCI tool for annual MHCCI calculation.
  - For example, when calculating the annual MHCCI for 2020, the data of all pay items awarded during **the year 2020** have to be imported, even though pay items awarded in the first quarter of 2020 were already imported before for calculating quarterly MHCCI for 2020 Q1.

**4.2 MHCCI Calculation**

Once the Excel data is imported successfully, the MHCCIs at the state level, as well as indices for specific regions and item categories, will be calculated automatically. Notably, it may take up to 20 minutes to complete the calculation. The status bar at the left-bottom of the GUI will display the status of the tool. Upon completion of the MHCCI calculation, the message, "*Calculation is completed*" will be shown in the status bar.

Please be patient.

## 5. FORECASTING MHCCI

The MHCCI tool can also forecast the MHCCI values for the next five years. The user has to select the frequency, i.e., 'Quarterly' or 'Annual', in the MHCCI aggregation panel so that the quarterly or annual MHCCIs will be forecasted accordingly. Once the 'Predict' button is clicked, the forecast algorithms embedded in the tool will be triggered to make the prediction. Upon completion of forecast, the predicted MHCCI values will then be displayed in the chart and table in the GUI, as shown in Figure 8.
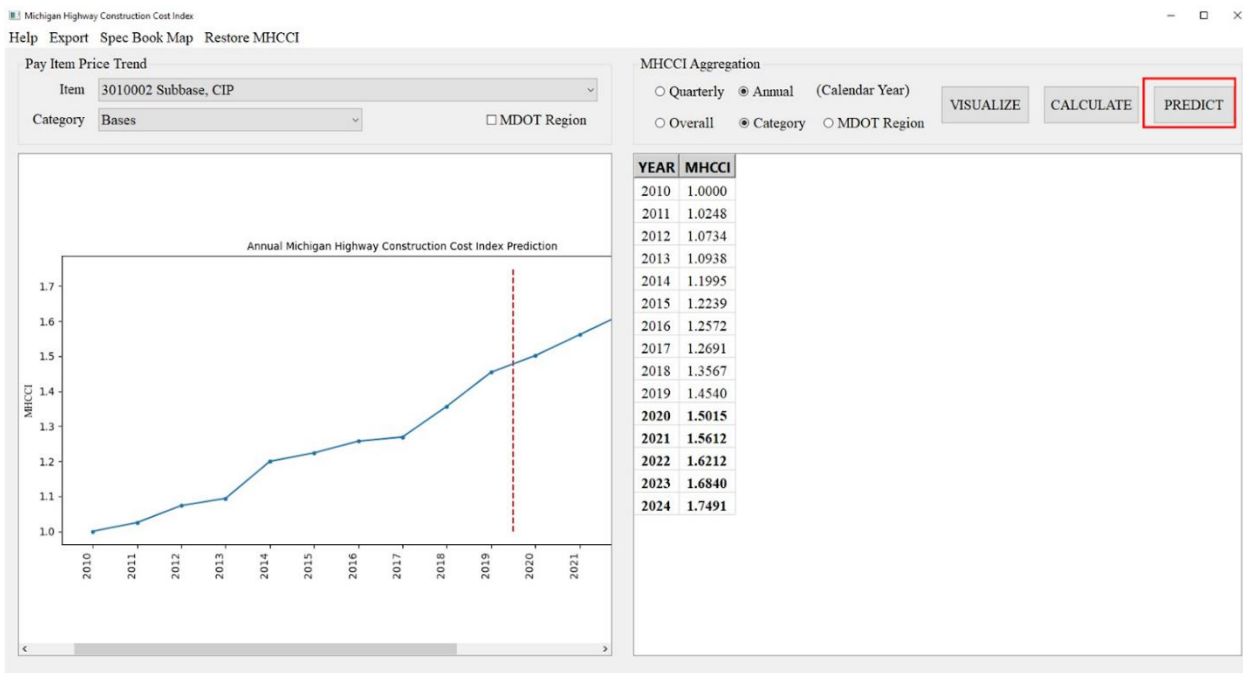


*Figure 8. MHCCI Forecast*

## 6. EXPORTING RESULTS

In addition to the GUI data visualization, the MHCCI results can also be exported into an excel file using the 'EXPORT' tap on the top of the GUI (See Figure 9). The user can export the calculated MHCCI values and MHCCI predictions into individual Excel files, as well as the trend chart of bid price and MHCCIs.
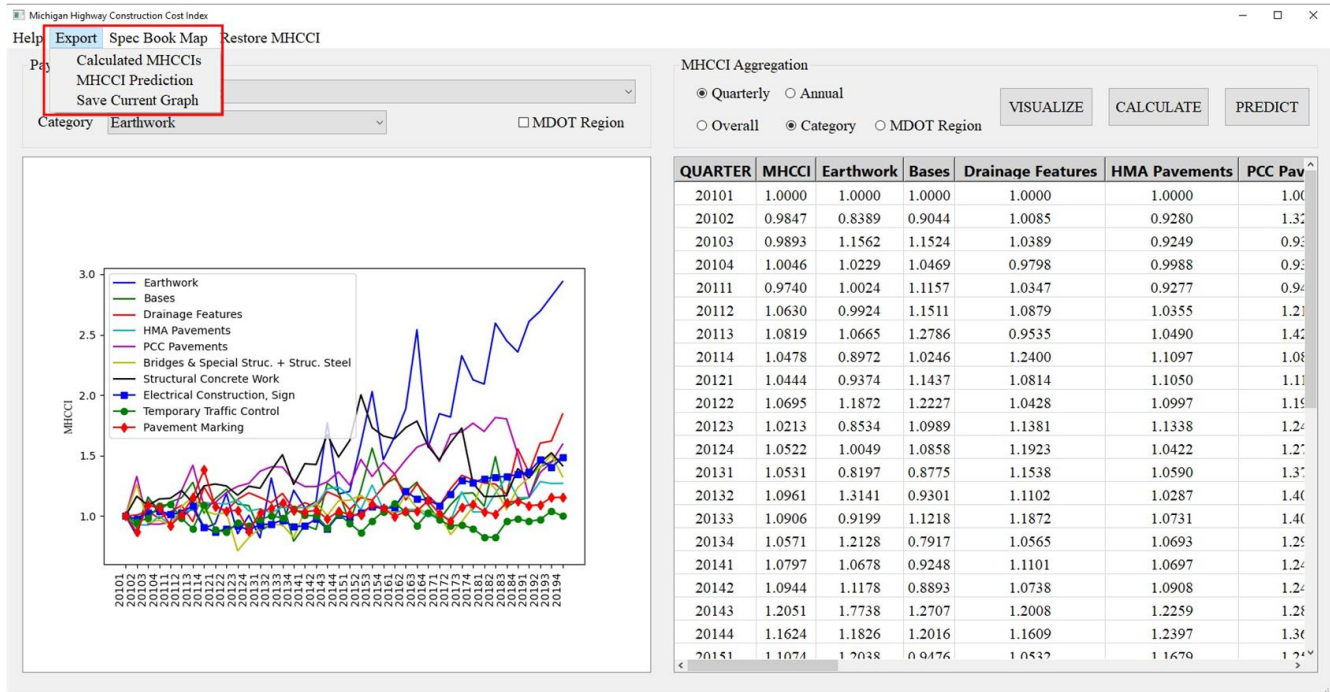


*Figure 9. Export MHCCI results*

## 7. MAPPING SPEC BOOKS

Users can incorporate changes in the 2020 SPEC BOOK into the MHCCI calculation. Essentially, a spec book map was developed to link pay items across different editions of SPEC BOOKs. This tool allows users to modify the map so that new changes in the 2020 SPEC BOOK can be considered in the MHCCI calculation.

Once the 'Open' button is clicked, the MHCCI tool will open the spec book map in Excel, as shown in **Figure 10** and **Figure 11**.
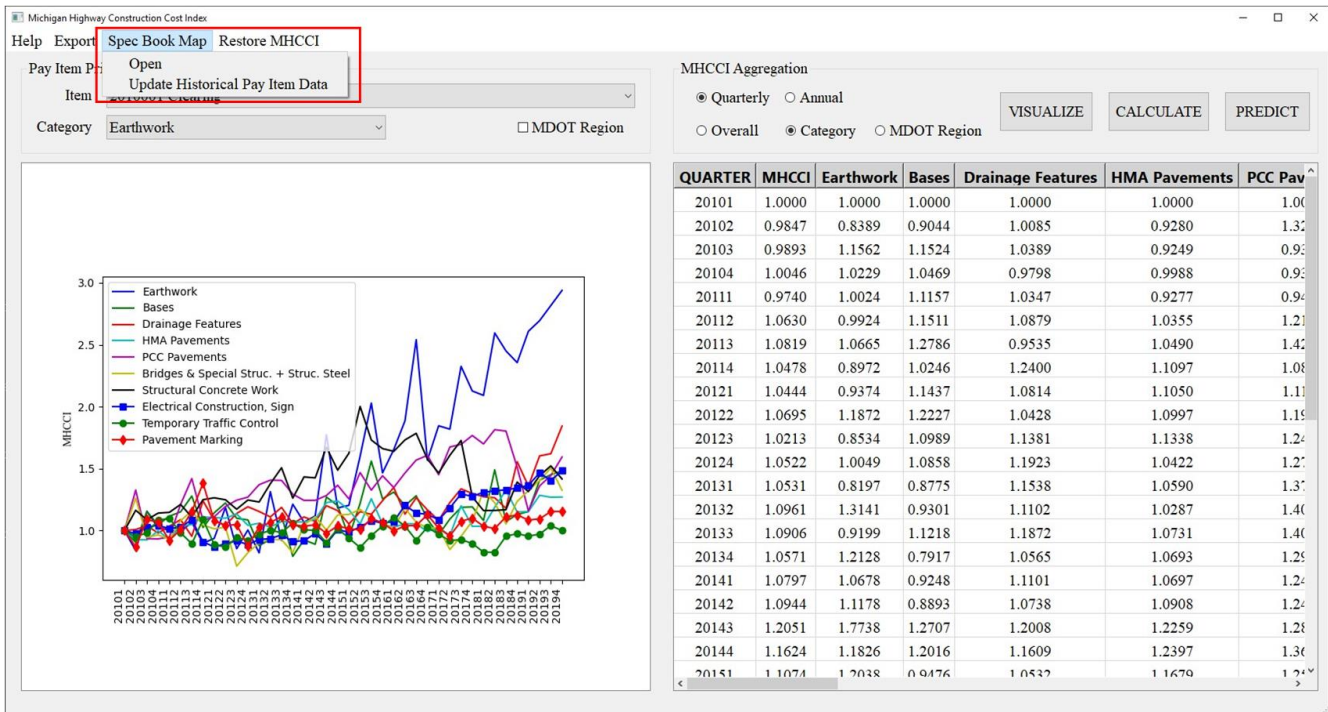


*Figure 10. Spec Book Map menu*

**7.1 Modify SPEC BOOK MAP in Excel**

Each row in the SPEC BOOK MAP (shown in Figure 11) represents a unique pay item in the SPEC BOOKs and has a unique ID in this spreadsheet's first column. The pay items in the same row are the same pay item, even though their item numbers and/or item descriptions vary across different SPEC BOOKs. For example, the pay item with ID of 3978 is '*Wireless Intercn, Sign Mtd Flasher, Master*'. Its item number is 8200390 in the 2003 edition and changed to 8200490 in both the 2012 and 2020 editions. The user can add, delete, or revise pay items (i.e., item number, item description, and unit) in the **2020 SPEC BOOK,** as shown in Figure 11.
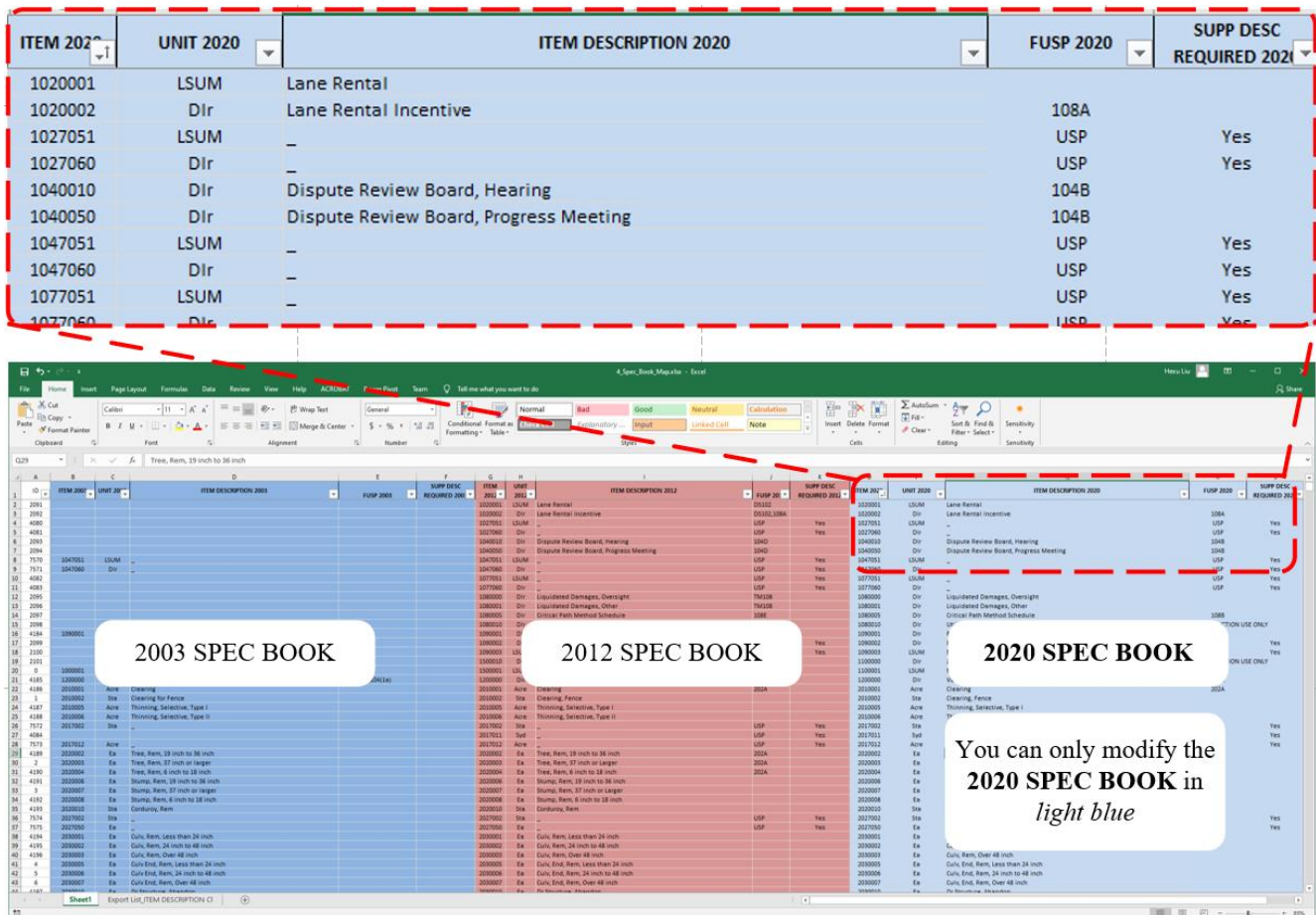


*Figure 11. Spec Book Map*

To add a new pay item, the user has to navigate to an empty row at the bottom of this map (e.g., whose ID is empty as shown in Figure 12); then, type its item number in the column of 'ITEM 2020', its description in 'ITEM DESCRIPTION 2020', and its unit in 'UNIT 2020'.
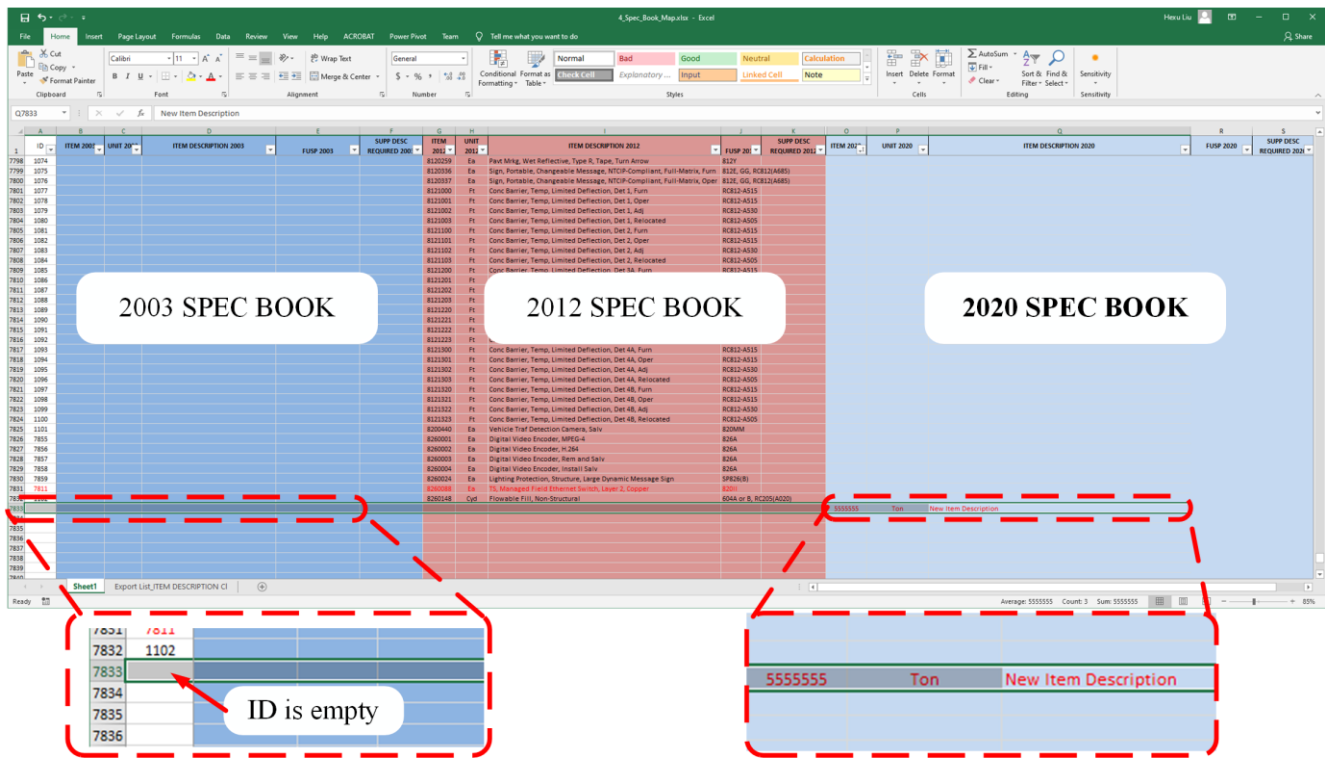


*Figure 12. Cost item removal*

The user can also modify an existing item in the 2020 SPEC BOOK by updating the corresponding column.

If a pay item is not used any longer, the user can simply **empty** its item number, description, unit, FUSP, and SUPP DESC in the 2020 SPEC BOOK (i.e., light blue area). Notably, users cannot delete the row from the spreadsheet.

To incorporate changes in the SPEC BOOK MAP (i.e., the Excel file), the user has to close and save the Excel file and then click the 'Update Historical Pay Item Data' button. After that, this MHCCI tool will automatically reflect the changes by updating the trends of pay items' bid prices and using the new map for future MHCCI calculations.

**8. RESTORING MHCCI VALUES**

The MHCCI tool provides functions to drop newly-calculated MHCCI values. There are four options to restore MHCCI values as shown in Figure 13, namely, 1) To Previous Calculation: Quarterly MHCCI, 2) To Previous Calculation: Annual MHCCI, 3) To 2019 Quarter 4: Quarterly MHCCI, and 4) To Year 2019.

For example, once 'To Previous Calculation: Quarterly MHCCI' is clicked, the newly-calculated MHCCI values will be dropped.

The user can also drop all quarterly MHCCI values calculated by end-users by clicking the 'To 2019 Quarter 4: Quarterly MHCCI' button.
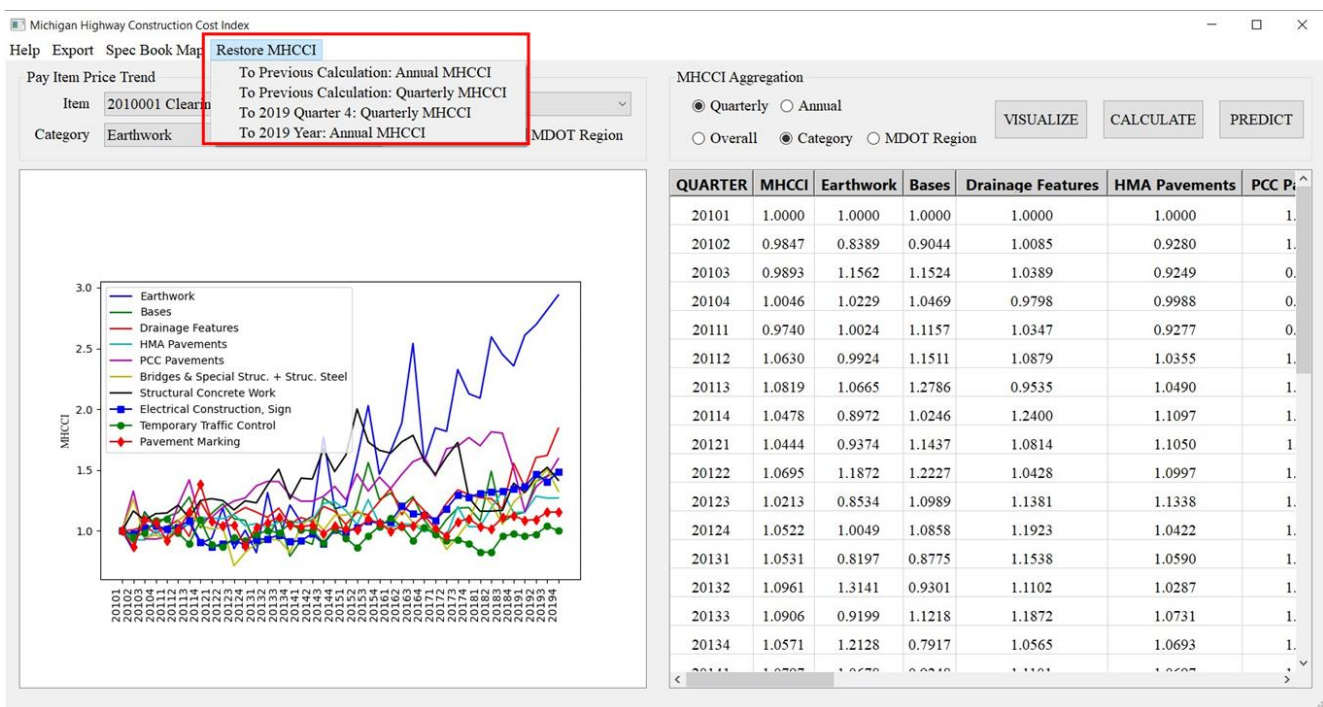


*Figure 13. Restore menu*

## 9. HELP

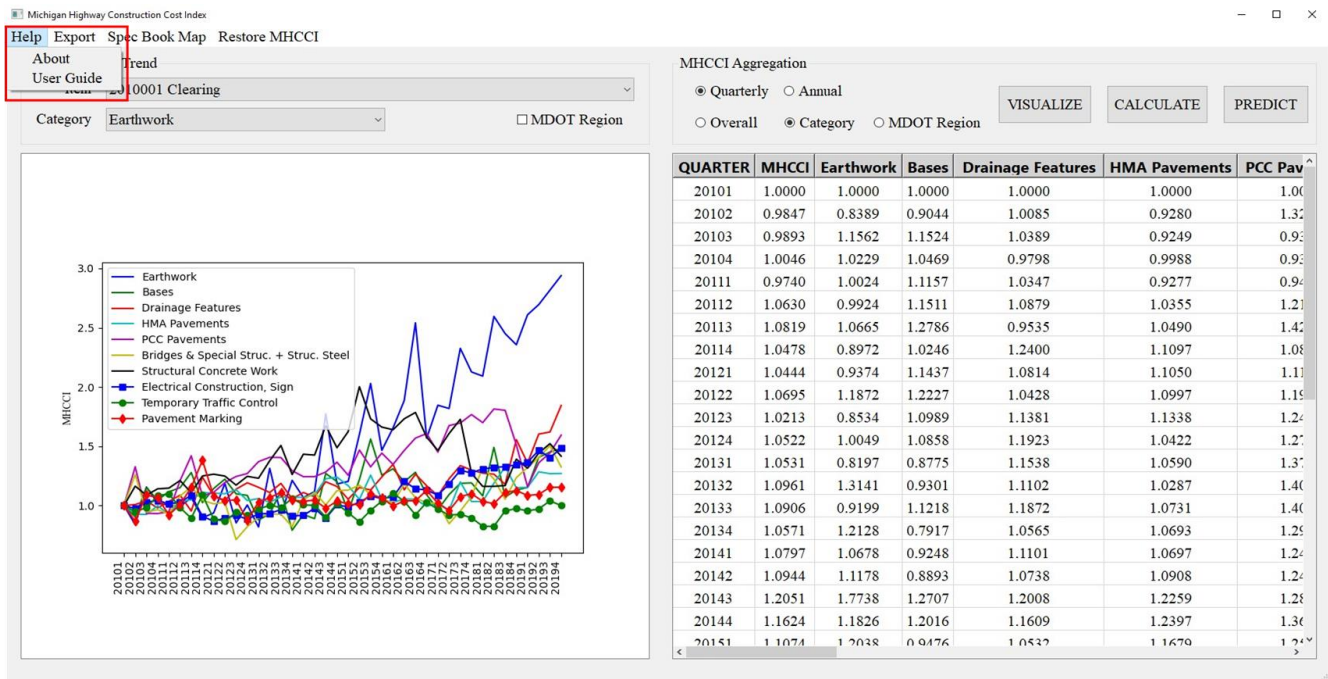There are two buttons under "Help" (See Figure 14), including 1) About and 2) User Guide.



*Figure 14. Help Menu*

### 9.1 About

Displays information about the developed MHCCI calculation tool (See Figure 15).

Contact: hexu.liu@wmich.edu for any help, feedback, or suggestions.
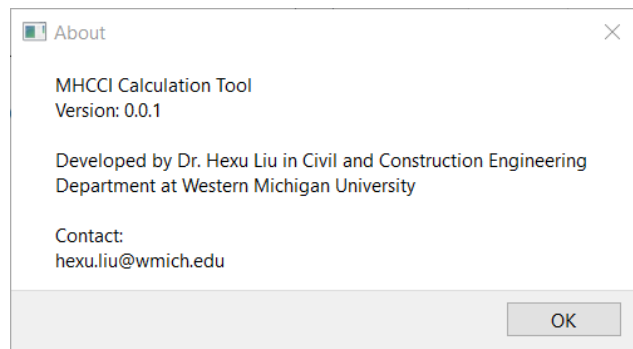


*Figure 15. Information of MHCCI calculation tool*

### 9.2 User guide

Opens this user guide by clicking the "User Guide" button.